iBiome - STP User Guide

RAPTOR™

Intelligent Cyber Secure Platform

Version: 1.10.06-1, Date: January 2022

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GLOSSARY ENTRIES

802.1D

IEEE 802.1D is the Ethernet MAC bridges standard which includes Bridging, Spanning Tree and others. It is standardized by the IEEE 802.1 working group. It includes details specific to linking many of the other 802 projects including the widely deployed 802.3 (Ethernet), 802.11 (Wireless LAN) and 802.16 (WiMax) standards.
Bridges using virtual LANs (VLANs) have never been part of 802.1D, but were instead specified in separate standard, 802.1Q originally published in 1998.
By 2014, all the functionality defined by IEEE 802.1D has been incorporated into either IEEE 802.1Q (Bridges and Bridged Networks) or IEEE 802.1AC (MAC Service Definition).

802.1Q

IEEE 802.1Q, often referred to as DOT1Q or 1Q, is the networking standard that supports virtual LANs (VLANs) on an IEEE 802.3 Ethernet network. It is the most widely used encapsulation method for VLAN tagging.

802.1X

IEEE 802.1X is an IEEE Standard for port-based Network Access Control (PNAC). 802.1X authentication requires a client, an authenticator, and an authentication server. The client is a device that wants to connect to the network.

802.1W

IEEE 802.1W feature provides rapid traffic reconvergence for point-to-point links within a few milliseconds (0-500 milliseconds), following the failure of bridge or bridge point. This reconvergence occurs more rapidly than the reconvergence provided by the 802.1F spanning Tree Protocol (STP) or by RSTP.

AAA

Authentication, Authorization and Accounting (AAA) functionalities. AAA are provided by TACACS+. TACACS+ is used because it provides independently separate and modular authentication, authorization, and accounting (AAA) facilities achieved by a single access control server (the TACACS+ daemon).

AARP

AppleTalk Address Resolution Protocol (AARP). The AARP maps computers' physical hardware addresses to their temporarily assigned AppleTalk network addresses. AARP is functionally equivalent to Address Resolution Protocol (ARP). The AARP table permits management of the address mapping table on the managed device. This protocol allows Apple computers' AppleTalk hosts to generate their own network addresses

ABR

Area Border Router (ABR)

ACK

ACK stands for acknowledgment. ACK is one of the TCP flags.

TCP flags are various types of flag bits present in the TCP header. Each of them has its own significance. They initiate connections, carry data, and tear down connections. The commonly used TCP flags are SYN, ACK, RST, FIN, URG, PSH.

- SYN (synchronize): Packets that are used to initiate a connection.
- ACK (acknowledgment): Packets that are used to confirm that the data packets have been received, also used to confirm the initiation request and tear down requests.
- RST (reset): Signify the connection is down or maybe the service is not accepting the requests.
- FIN (finish): Indicate that the connection is being torn down. Both the sender and receiver send the FIN packets to gracefully terminate the connection.
- PSH (push): Indicate that the incoming data should be passed on directly to the application instead of getting buffered.
- URG (urgent): Indicate that the data that the packet is carrying should be processed immediately by the TCP stack

ACL

An access-control list (ACL) is a list of permissions associated with a system resource (object). An ACL specifies which users or system processes are granted access to objects, as well as what operations are allowed on given objects. Each entry in a typical ACL specifies a subject and an operation. For instance, if a file object has an ACL that contains (Admin: read, write; guest 1: read), this would give Admin permission to read and write the file, and only give guest 1 permission to read it.

AES

The Advanced Encryption Standard (AES) is a symmetric-key block cipher algorithm and U.S. government standard for secure and classified data encryption and decryption.

ARAP

Apple Remote Access Protocol (ARAP); the Apple Remote Access Protocol (ARAP) sends traffic based on the AppleTalk protocol across PPP links and ISDN switched-circuit networks. ARAP is still pervasive in the Apple market, although the company is attempting to transition into an Apple-specific TCP stack for use over a PPP link.

ARP

ARP (Address Resolution Protocol). The ARP is a communication protocol used for discovering the link layer address, such as a MAC address, associated with a given Internet layer address, typically an IPv4 address.

AS

Autonomous System (AS)

ASBR

Autonomous Border System Router (ASBR)

BDR

BDR stands for Backup Designated Router.

BFD

Bidirectional Forwarding Detection (BFD) is a super fast protocol that is able to detect link failures within milliseconds or even microseconds. BFD runs independent from any other (routing) protocols. Once it’s up and running, you can configure protocols like OSPF, EIGRP, BGP, HSRP, MPLS LDP

etc. to use BFD for link failure detection instead of their own mechanisms. When the link fails, BFD will inform the protocol

BIDIR-PIM

Bi-directional Sparse Mode (PIM-SM); Derived from PIM-SM, BIDIR-PIM builds and maintains a bidirectional RPT, which is rooted at the RP and connects the multicast sources and the receivers. Along the bidirectional RPT, the multicast sources send multicast data to the RP, and the RP forwards the data to the receivers. Each router along the bidirectional RPT needs to maintain only one (*, G) entry, saving system resources.

Another difference between PIM sparse mode and PIM bidirectional mode is that with sparse mode traffic only flows down the shared tree. Using PIM bidirectional mode, traffic will flow up and down the shared tree. When the multicast packets arrive at the RP, they will be forwarded down the shared tree (if there are receivers) or dropped (when we don't have receivers).

BMS

Best Master Clock (BMS); The ordinary clock executes the port state machine and BMC (Best Master Clock) algorithm to select the *PTP* port state.

BOOTP

The Bootstrap Protocol (BOOTP) is a computer networking protocol used in Internet Protocol networks to automatically assign an IP address to network devices from a configuration server. The BOOTP was originally defined in RFC 951.

BPDU

Bridge Protocol Data Units (BPDUs) are frames that contain information about the spanning tree protocol (STP). A switch sends BPDUs using a unique source MAC address from its origin port to a multicast address.

There are two kinds of BPDUs for 802.1D Spanning Tree:[

- Configuration BPDU, sent by root bridges to provide information to all switches.
- TCN (Topology Change Notification), sent by bridges towards the root bridge to notify changes in the topology, such as port up or port down.

BPS

BPS (Bits-per-second)

BR

Border Router (BR)

BSD

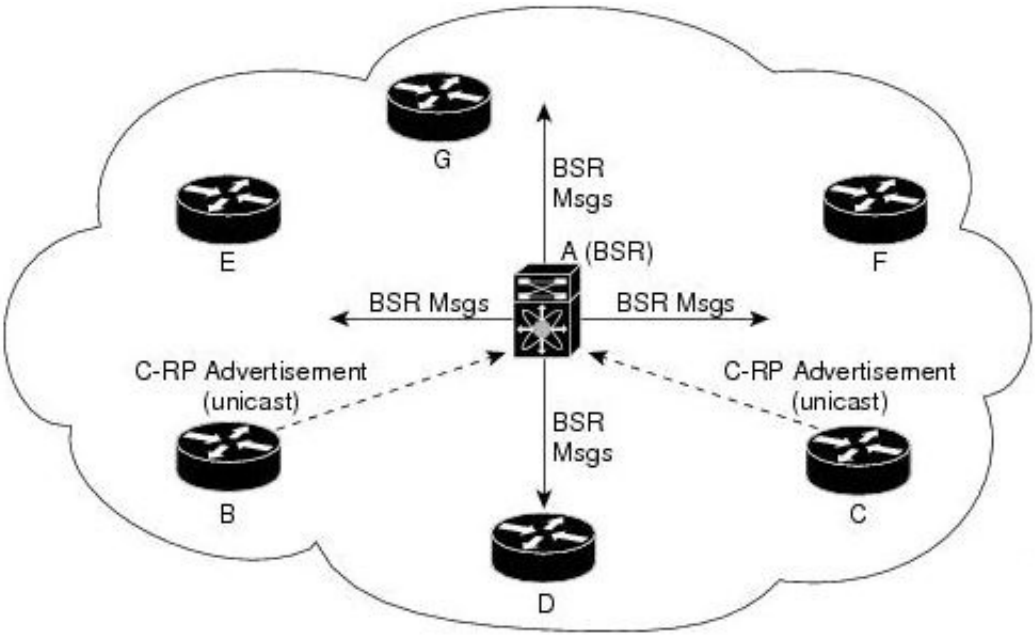
Berkeley Software Distribution (BSD)

BSR

The bootstrap router (BSR) ensures that all routers in the PIM domain have the same RP cache as the BSR. You can configure the BSR to help you select an RP set from BSR candidate RPs. The function of the BSR is to broadcast the RP set to all routers in the domain. You select one or more candidate BSRs to manage the RPs in the domain. Only one candidate BSR is elected as the BSR for the domain.

This figure shows the BSR mechanism. Router A, the software-elected BSR, sends BSR messages out all enabled interfaces (shown by the solid lines in the figure). The messages, which contain the RP set, are flooded hop by hop to all routers in the network. Routers B and C are candidate RPs that

send their candidate-RP advertisements directly to the elected BSR (shown by the dashed lines in the figure).
The elected BSR receives candidate-RP messages from all the candidate RPs in the domain. The bootstrap message sent by the BSR includes information about all of the candidate RPs. Each router uses a common algorithm to select the same RP address for a given multicast group.



CA

Certificate Authorization (CA)

CBP

Customer Backbone Port (CBP)

CBS

Committed burst size (CBS). During periods of average traffic rates below the Committed information rate (CIR), any unused bandwidth capacity accumulates up to a maximum amount defined by the CBS. Short periods of bursting traffic (back-to-back traffic at averages rates that exceed the CIR) are also categorized as green provided that unused bandwidth capacity is available.

CEP

Customer Edge Port (CEP). The Customer Edge Port (CEP) and each Provider Edge Port are treated as separate Bridge Ports by the spanning tree protocol. If the C-VLAN component connects to the S-VLAN component with a single Provider Edge Port, and the associated service instance supports no more than two customer interfaces, then all frames (including Spanning Tree BPDUs) addressed to the Bridge Group Address may be relayed between the two Ports of the C-VLAN component without modification. Otherwise, the Spanning Tree Protocol Entity shall execute the Rapid Spanning Tree Protocol (RSTP, Clause 17 of IEEE Std 802.1D), as modified by the provisions of this subclause.

CFI

Canonical Format Identifier (CFI). If Drop Eligible Indicator (DEI) bit is enabled in 802.1ad header or has Canonical Format Identifier (CFI) bit enabled in 802.1q header on an arriving packet, such packets will be dropped using QoS.

MS-CHAP

CHAP stands for Challenge Handshake Authentication Protocol. MS-CHAP is the Microsoft version of the Challenge-Handshake Authentication Protocol, CHAP. The protocol exists in two versions, MS-CHAPv1 (defined in RFC 2433) and MS-CHAPv2 (defined in RFC 2759). MS-CHAPv2 provides mutual authentication between peers by piggybacking a peer challenge on the Response packet and an authenticator response on the Success packet.

CIDR

Classless Inter Domain Routing (CIDR).

CIR

Committed information rate (CIR) is defines the guaranteed bandwidth for traffic arriving at or departing from the interface under normal line conditions.

CIST

The Common and Internal Spanning Tree (CIST) is a collection of the ISTs in each MST region.

CLI

Command line interface (CLI) is a text-based interface that is used to operate software and operating systems while allowing the user to respond to visual prompts by typing single commands into the interface and receiving a reply in the same way

CLKIWF

CLKIWF is short for Clock InterWorking Function.

CoS

Output queue scheduling defines the class-of-service (CoS) properties of output queues. Based on certain types of traffic are preferred. The level of service is determined by the egress port queue to which the traffic is assigned. When traffic is queued for transmission, the rate at which it is serviced depends on how the queue is configured and possibly the amount of traffic present in other queues for that port.

Some traffic is classified for service (i.e., packet marking) before it arrives at the switch. If you decide to use these classifications, you can map this traffic to egress queues by setting the CoS in the Queue table.

CPLD

A Complex Programmable logic device (CPLD) is a logic device with completely programmable AND/OR arrays and macrocells. Macrocells are the main building blocks of a CPLD, which contain complex logic operations and logic for implementing disjunctive normal form expressions. AND/OR arrays are completely reprogrammable and responsible for performing various logic functions.

CPU

The central processing unit (CPU) is the primary component of a computer that processes instructions. It runs the operating system and applications, constantly receiving input from the user or active software programs. It processes the data and produces output.

CRT

CRT stands for "Internet security certificate.

CSR

Certificate Signing Request (CSR)

CST

common spanning tree (CST); The common spanning tree (CST) that interconnects the MST regions and single spanning trees

CTS

CTS stands for Clear to Send. Request to Send (RTS)/CTS Flow Control is another flow control mechanism that is part of the RS232 standard.

CVID

The C-VID registration table is as follows:

Table 1: C-VID registration table

C-VID Registration Table	Description
Cvid value	The value of the Customer VLAN id on the Customer edge port. (Table key)
Svid Value	The S-VLAN tag. Auto creates an S-VLAN component and the CNP and PNP and links the PEP of the C-VLAN component to the CNP.
Untagged-pep	A boolean indicating frames for this C-VLAN should be forwarded untagged through the Provider Edge Port (PEP).
Untagged-cep	A boolean indicating frames for this C-VLAN should be forwarded untagged through the Customer Edge Port (CEP).

CVLAN

Set of ports & inner VLANs (CVLAN); or C-VLAN or Customer Bridge (CB)

DB9

DB9 refers to a common connector type from the D-Subminiatures (D-Sub) connector family, which when introduced, was among the smallest connectors used on computer systems. DB9 houses 9 pins (for the male connector) or 9 holes (for the female connector). DB9 connectors were once very common on PCs and servers. Today, the DB9 has mostly been replaced by more modern interfaces such as USB, PS/2, Firewire, and others.

DB25

The DB25 connector is an analog socket, with 25 pins, from the D-Subminiatures (D-Sub) connector family. The prefix “D” represents the D-shape of the connector shell. The DB25 connector is mainly used in serial and parallel ports, allowing asynchronous data transmission according to the RS-232 standard (RS-232C).

DCD

DCD stands Data Carrier Detect. The description is modem connected to another.

DEC

Digital Equipment Corporation (DEC)

DEI

Drop Eligible Indicator (DEI). If DEI bit is enabled in 802.1ad header or has Canonical Format Identifier (CFI) bit enabled in 802.1q header on an arriving packet, such packets will be dropped using QoS.

DES

The Advanced Encryption Standard (AES) is a symmetric-key block cipher algorithm and U.S. government standard for secure and classified data encryption and decryption.

DF

Designated Forwarder (DF).

DHCP

Dynamic Host Configuration Protocol (DHCP)

DITA

Darwin Information Typing Architecture (DITA); the DITA specification defines a set of document types for authoring and organizing topic-oriented information, as well as a set of mechanisms for combining, extending, and constraining document types.

D-LAG

Distributed Link Aggregation (D-LAG or DLAG)

DLF

The Destination Lookup Failure (DLF). When a packet arrives at the device and the device doesn't have an entry for the destination MAC address in its MAC address table, the packet is classified as a Destination Lookup Failure (DLF)

DM

DM stands for Dense Mode. Protocol-Independent Multicast Dense Mode (PIM-DM) uses dense multicast routing.

DNAT

Destination network address translation (DNAT) is a technique for transparently changing the destination IP address of an end route packet and performing the inverse function for any replies.

DNS

Domain Name System

DOT1Q

IEEE 802.1Q, often referred to as DOT1Q or 1Q, is the networking standard that supports virtual LANs (VLANs) on an IEEE 802.3 Ethernet network. It is the most widely used encapsulation method for VLAN tagging.

Dot1x

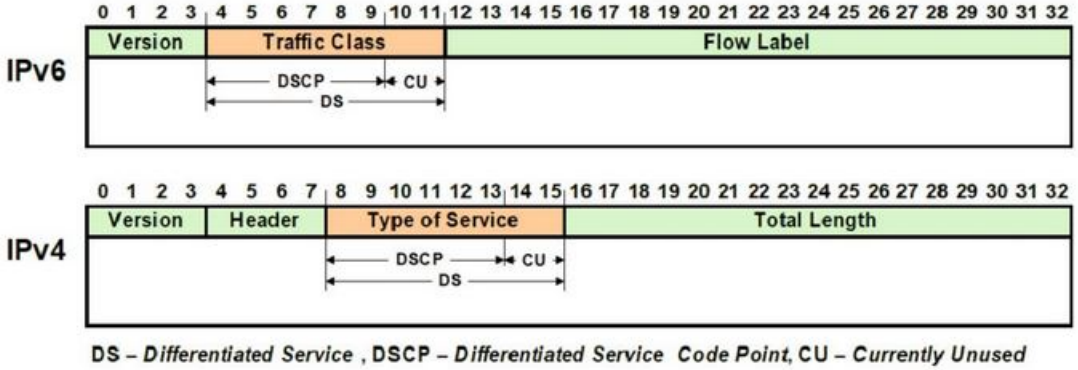
Dot1x Authentication is enabled when dot1x system-auth-control is enabled, and aaa authentication dot1x default is local. If you enable authentication on a port by using the default setting of dot1x port-control, which is force-authorized, it disables 802.1X authentication and causes the port to transition to the authorized state without any authentication exchange required. The port transmits and receives normal traffic without 802.1X-based authentication of the client

DR

The Designated Router (DR) is the router that will forward the PIM join message from the receiver to the RP (rendezvous point).

DS

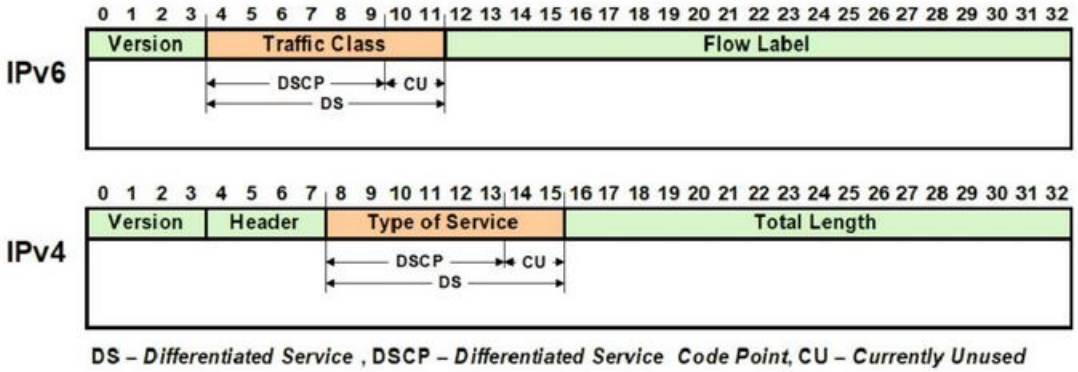
Differentiated Services (DS).



DS – *Differentiated Service* , DSCP – *Differentiated Service Code Point*, CU – *Currently Unused*

DSCP

A Differentiated Services Code Point (DSCP) is a packet header value that can be used to request (for example) high priority or best effort delivery for traffic.



DS – *Differentiated Service* , DSCP – *Differentiated Service Code Point*, CU – *Currently Unused*

DSR

DSR stands Data Set Ready. The description is ready to communicate.

DST

Daylight Saving Time (DST) is a system of setting clocks ahead so that both sunrise and sunset occur at a later hour. The effect is additional daylight in the evening. Many countries observe DST, although most have their own rules and regulations for when it begins and ends. The dates of DST may change from year to year

DTR

DTR stands Data Terminal Ready. The description is ready to communicate.

DUT

Device under Test (DUT)

DVMRP

Distance Vector Multicast Routing Protocol (DVMRP)

E2E

End-to-end (E2E) transparent clock for Precision Time Protocol (PTP). With an E2Etransparent clock, only the residence time is included in the timestamp in the packet.

EAP

Extensible Authentication Protocol (EAP) is an authentication framework frequently used in network and Internet connections. EAP is usually tunnelled over RADIUS between the Authenticator and the Authentication Server. 802.1x uses EAP.

EAP is an authentication framework, not a specific authentication mechanism. Commonly used modern methods capable of operating in wireless networks include EAP-TLS, EAP-SIM, EAP-AKA, LEAP and EAP-TTLS. Requirements for EAP methods used in wireless LAN authentication are described in RFC 4017.

The Lightweight Extensible Authentication Protocol (LEAP) method was developed by Cisco Systems prior to the IEEE ratification of the 802.11i security standard.

EAPOL

Extensible Authentication Protocol (EAP) over LAN (EAPoL) is used between the Supplicant (software on your laptop) and the Authenticator (switch)

EBS

The Excess Burst size (EBS) specifies how much data above the committed burst size (CBS) a user can transmit. The EBS is the size up to which the traffic is allowed to burst without being discarded. EBS allows for moderate periods of bursting traffic that exceeds both the committed information rate (CIR) and the committed burst size (CBS).

ECN

Explicit Congestion Notification (ECN)

EGP

Exterior Gateway Protocol (EGP) is a defunct routing protocol used in autonomous systems to exchange data between surrounding gateway sites. Border Gateway Protocol (BGP) supplanted EGP, widely utilized by research institutes, universities, government agencies, and commercial companies (BGP). EGP is built on poll instructions to request update answers and periodic message exchange polling for neighbor reachability.

EIR

The excess information rate (EIR) specifies the rate above the CIR (committed information rate) at which traffic is allowed into the network and that may get delivered if the network is not congested. The EIR has an additional parameter associated with it called the excess burst size (EBS). The EBS is the size up to which the traffic is allowed to burst without being discarded.

ESD

ElectroStatic Discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

EXEC

exec: Protocol

Commands that are invoked using the exec: protocol must be executable as standalone commands. Commands that are built into a command interpreter or other program cannot be executed directly, but must be executed (if possible) within the context of the application that provides them. For example, the following seed URL would not work on Microsoft Windows systems because the dir command is built into the Windows command interpreter (cmd.exe):

exec: dir e:\data
To use the exec protocol with commands that are built into the Windows command interpreter, you must do something as the following:
exec: cmd /c dir 'e:\data'

EVB

Edge Virtual Bridge (EVB) is an IEEE standard that involves the interaction between virtual switching environments in a hypervisor and the first layer of the physical switching infrastructure. The EVB enhancements are following 2 different paths – 802.1qbg and 802.1qbh.

EVC

Ethernet Virtual Connection (EVC).

FCS

A frame check sequence (FCS) is an error-detecting code added to a frame in a communication protocol. Frames are used to send payload data from a source to a destination.

FDB

Forwarding Database (FDB)

FID

Filtering ID (FID)

FHRP

First Hop Redundancy Protocol (FHRP)

FPGA

The Field Programmable Gate Array (FPGA) is a programmable logic device that can have its internal configuration set by the firmware.

FTP

The File Transfer Protocol (FTP) is a standard communication protocol used for the transfer of computer files from a server to a client on a computer network. FTP is built on a client–server model architecture using separate control and data connections between the client and the server.[1] FTP users may authenticate themselves with a clear-text sign-in protocol, normally in the form of a username and password, but can connect anonymously if the server is configured to allow it. For secure transmission that protects the username and password, and encrypts the content, FTP is often secured with SSL/TLS (FTPS) or replaced with SSH File Transfer Protocol (SFTP).

GARP

GARP (Generic Attribute Registration Protocol) is a local area network (LAN) protocol that defines procedures by which end stations and switches can register and deregister attributes, such as network identifiers or addresses, with each other. Every end station and switch thus has a record, or list, of all the other end stations and switches that can be reached at any given time.
When an attribute for an end station or switch is registered or deregistered according to GARP, the set of reachable end stations and switches, called participants, is modified according to specific rules. The defined set of participants at any given time, along with their attributes, is a subset of the network topology called the reachability tree. Data frames are propagated only to registered end stations. This prevents attempts to send data to end stations that are not reachable.

GGP

Gateway-to-Gateway Protocol (GGP) is an obsolete protocol defined for routing datagrams between Internet gateways. It was first outlined in 1982. The GGP was designed as an IP datagram service similar to the TCP and the UDP.

GMRP

GARP Multicast Registration Protocol (GMRP) is a Generic Attribute Registration Protocol (GARP) application that provides a constrained multicast flooding facility similar to IGMP snooping.

GND

Ground

GPS

Global Positioning System

GR

Graceful Restart (GR)

GVRP

GVRP (GARP VLAN Registration Protocol or Generic VLAN Registration Protocol) is a protocol that facilitates control of virtual local area networks (VLANs) within a larger network. GVRP conforms to the IEEE 802.1Q specification, which defines a method of tagging frame s with VLAN configuration data

HA

High Availability (HA)

HDMI

HDMI (High-Definition Multimedia Interface) is digital interface capable of transmitting high-quality and high-bandwidth streams of audio and video between devices

HOL

Head-Of-Line (HOL) blocking should be prevented on a port. HOL blocking happens when HOL packet of a buffer cannot be switched to an output port (i.e. HOL occurs when a line of packets is held up by the first packet).

HTTP

Hyper Text Transfer Protocol (HTTP)

HTTPS

Hyper Text Transfer Protocol Secure (HTTPS)

IANA

Internet Assigned Numbers Authority (IANA)

ICMP

Internet Control Message Protocol

IDPR

Inter-domain Routing Protocol (IDPR). The objective of IDPR is to construct and maintain routes, between source and destination administrative domains, that provide user traffic with the requested services within the constraints stipulated for the domains transited.

IETF

Internet Engineering Task Force (IETF) is an open standards organization, which develops and promotes voluntary Internet standards, in particular the technical standards that comprise the Internet protocol suite (TCP/IP).

IGMP

The Internet Group Management Protocol (IGMP) is a communications protocol used by hosts and adjacent routers on IPv4 networks to establish multicast group memberships. IGMP is an integral part of IP multicast and allows the network to direct multicast transmissions only to hosts that have requested them.

IGP

Interior Gateway Protocol (IGP) is a type of routing protocol used for exchanging routing table information between gateways (commonly routers) within an autonomous system (for example, a system of corporate local area networks). This routing information can then be used to route network-layer protocols like IP.

IGRP

Interior Gateway Routing Protocol (IGRP) is a proprietary distance vector routing protocol that manages the flow of routing information within connected routers in the host network or autonomous system. The protocol ensures that every router has routing tables updated with the best available path. IGRP also avoids routing loops by updating itself with the changes occurring over the network and by error management.

IGS

The Internet Group Management Protocol (IGMP) Snooping (IGS) is designed to prevent hosts on a local network from receiving traffic for a multicast group they have not explicitly joined. It provides switches with a mechanism to prune multicast traffic from links that do not contain a multicast listener (an IGMP client). Essentially, IGS is a layer 2 optimization for the Layer 3 IGMP.

IKE

Internet Key Exchange (IKE)

IP

Internet Protocol (IP).

IPSec

IPSec (Internet Protocol Security) is a suite of protocols that provides security to Internet communications at the IP layer. The most common current use of IPSec is to provide a Virtual Private Network (VPN), either between two locations (gateway-to-gateway) or between a remote user and an enterprise network (host-to-gateway); it can also provide end-to-end, or host-to-host, security.

IPv4

IPv4 and IPv6 are Internet protocol version 4 and Internet protocol version 6. IPv4 supports:

- IPv4 has a 32-bit address length
- IPv4 binary bits are separated by a dot(.) whereas IPv6 binary bits are separated by a colon(:).
- IPv4 is a numeric addressing method whereas IPv6 is an alphanumeric addressing method
- It Supports Manual and DHCP address configuration
- In IPv4 end to end, connection integrity is Unachievable
- It can generate 4.29×109 address space

- Fragmentation performed by Sender and forwarding routers
- In IPv4 Packet flow identification is not available
- In IPv4 checksum field is available
- It has broadcast Message Transmission Scheme
- In IPv4 Encryption and Authentication facility not provided
- IPv4 has a header of 20-60 bytes.

IPv6

IPv6 stands for Internet protocol version 6. An IPv6 address consists of eight groups of four hexa-decimal digits. Anexample of IPv6 address is as follows
3001:0da8:75a3:0000:0000:8a2e:0370:7334
there are different ypes of IPv6 addresses:

- Unicast addresses—it identifies a unique node on a network and usually refers to a single sender or a single receiver.
- Multicast addresses—it represents a group of IP devices and can only be used as the destination of a datagram.
- Anycast addresses—it is assigned to a set of interfaces that typically belong to different nodes.

IRTP

Internet Reliable Transaction Protocol (IRTP) is a transport level host to host protocol designed for an Internet environment. It provides reliable, sequenced delivery of packets of data between hosts and multiplexes / demultiplexes streams of packets from/to user processes representing ports.

ISAKMP

Internet Security Association and Key Management Protocol (ISAKMP)

ISDN

Integrated Services Digital Network (ISDN)

ISL

ISL stands for Inter-Switch Link which is one of the VLAN protocols. The ISL is proprietary of Cisco and is used only between Cisco switches. It operates in a point-to-point VLAN environment and supports up to 1000 VLANs and can be used over Fast Ethernet and Gigabit Ethernet links only.

ISP

Internet service provider (ISP)

ISS

Intelligent Switch Solution (ISS).

IST

The Internal Spanning Tree (IST) instance receives and sends BPDUs to the CST. The IST can represent the entire MST region as a CST virtual bridge to the outside world.

IVL

Independent VLAN Learning (IVL)

IVR

Inter VLAN Routing (IVR)

IWF

InterWorking Function (IWF).

L2GP

Layer 2 Gateway Port (L2GP)

LA

Link Aggregation

LACP

Link Aggregation Control Protocol

LAG

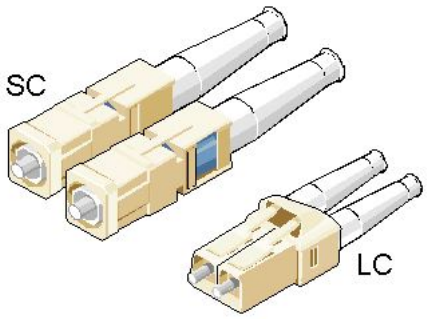
Link Aggregation Group

LAN

Local Area Network

LC

LC (Lucent Connector) is a miniaturized version of the fiber-optic SC (Standard Connector) connector. It looks somewhat like the SC, but is half the size with a 1.25mm ferrule instead of 2.5mm.



SC and LC Connectors

LED

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment.

LLDP

Link Layer Discovery Protocol (LLDP)

LM

Line Module (LM)

LSA

Link State Advertisement (LSA)

LSDB

link state database (LSDB)

LSR

link state routing (LSR)

MAC

Media access control (MAC) is a sublayer of the data link layer in the seven-layer OSI network reference model. MAC is responsible for the transmission of data packets to and from the network-interface card, and to and from another remotely shared channel.

MAU

Medium Attachment Unit (MAU)

MD5

Message Digest Algorithm 5 (MD5) is a cryptographic hash algorithm that can be used to create a 128-bit string value from an arbitrary length string.

A hash function provides encryption using an algorithm and no key. A variable-length plaintext is “hashed” into a (typically) fixed-length hash value (often called a “message digest” or simply a “hash”). Hash functions are primarily used to provide integrity; if the hash of a plaintext changes, the plaintext itself has changed.

Common older hash functions include Secure Hash Algorithm 1 (SHA-1), which creates a 160-bit hash and Message Digest 5 (MD5), which creates a 128-bit hash.

Although there has been insecurities identified with MD5, it is still widely used, and its most common use is to verify the integrity of files.

MDI

Media Independent Interface (MDI) and Media Independent Interface with Crossover (MDIX) are basically ports on a computer and a network switch, router, or hub, respectively.

MDIX

Media Independent Interface with Crossover (MDIX) and Media Independent Interface (MDI) are basically ports on a computer and a network switch, router, or hub, respectively.

MED

Media Endpoint Discovery (MED); LLDP does not contain the capability of negotiating additional information such as PoE management and VLAN assignments. This capability was added as an enhancement known as Media Endpoint Discovery or MED, resulting in the enhanced protocol LLDP-MED.The MED enhancement has been standardized by the Telecommunications Industry Association in standard number ANSI/TIA-1057.

MHRP

Multipath Hybrid Routing Protocol (MHRP) is a multipath routing protocol for hybrid Wireless Mesh Network (WMN), which provides security and uses technique to find alternate path in case of route failure.

MIB

Management Information Base (MIB) is the hierarchical database used by the simple network management protocol (SNMP) to describe the particular device being monitored.

MIB OID

Management Information Base (MIB) is the hierarchical database used by the simple network management protocol (SNMP) to describe the particular device being monitored.

MIB Object IDentifier (OID), as known as a MIB object identifier in the SNMP, is a number assigned to devices in a network for identification purposes. OID numbering is hierarchical. Using the IETF notation of digits and dots, resembling very long IP addresses, various registries such as ANSI assign high-level numbers to vendors and organizations. They, in turn, append digits to the number to identify individual devices or software processes.

MIC

Media redundancy Interconnection Client (MIC) is a member node of a MRP Interconnect ring.

MIM

Media redundancy Interconnection Manager (MIM) is a node in a MRP Interconnect ring which acts a redundancy manager.

MLDS

Multicast Listener Discovery Snooping (MLDS) constrains the flooding of IPv6 multicast traffic on VLANs. When MLDS is enabled on a VLAN, adevice examines MLD messages between hosts and multicast routers and learns which hosts are interested in receiving traffic for a multicast group. On the basis of what it learns, the device then forwards multicast traffic only to those interfaces in the VLAN that are connected to interested receivers instead of flooding the traffic to all interfaces.

MM

MultiMode (MM) Mode is in optical fiber with a larger core than singlemode fiber. Typically, MM has a core diameter of 50 or 62.5 µm and a cladding diameter of 125 µ.

MIC

Media redundancy Interconnection Client (MIC) is a member node of a MRP Interconnect ring.

MPLS

Multiprotocol Label Switching (MPLS) is a routing technique in telecommunications networks that directs data from one node to the next based on short path labels rather than long network addresses, thus avoiding complex lookups in a routing table and speeding traffic flows. The labels identify virtual links (paths) between distant nodes rather than endpoints. MPLS can encapsulate packets of various network protocols, hence the "multiprotocol" reference on its name.

MRA

Media Redundancy Automanager (MRA). To configure a Media Redundancy Automanager (MRA), the node or nodes elect an MRM by a configured priority value.

MRC

Media Redundancy Client (MRC) is a member node of a MRP ring.

MRM

Media Redundancy Manager (MRM) is a node in the network which acts a redundancy manager.

MRP

Media Redundancy Protocol (MRP) is a networking protocol designed to implement redundancy and recovery in a ring topology.

MSR

1) MSR (MIB Save and Restore).
2) Model-Specific Register (*MSR*)

MST

MST (Multiple Spanning Tree) is the version of STP that allows multiple VLANs to a single instance. It is the standard based protocol defined with IEEE 802.1s. Unlike other spanning tree protocols, in which all the spanning tree instances are independent, MST establishes and maintains IST, CIST, and CST spanning trees.

MSTI

Multiple spanning trees, called MSTIs; inside an MST region, multiple spanning trees, called MSTIs, are calculated. Among these MSTIs, MSTI 0 is the IST.

MSTP

Multiple Spanning-Tree Protocol

MTU

Maximum Transmission Unit (MTU)

MVLAN

Multicast VLANs (MVLAN)

NAP

Network Access Protection (NAP)

NAPT

Network address port translation (NAPT) is a variation of the traditional *NAT*. NAPT extends the notion of translation one step further by also translating transport identifiers (e.g., TCP and UDP port numbers, ICMP query identifiers).

NAS

The Network Access Server (NAS) is the front line of authentication – it's the first server that fields network authentication requests before they pass through to the RADIUS. The NAS Identifier (NAS-ID) is a feature that allows the RADIUS server to confirm information about the sender of the authentication request.

NAT

Network address translation (NAT) is a method of mapping an IP address space into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device.

NBMA

NBMA (Non Broadcast Multi Access)

NBNS

NetBIOS Name Server where NetBIOS stands for Network Basic Input / Output System.

NC

NC (normally closed) is a closed (short) circuit creating a path for the current.

ND

Neighbor Discovery (ND); the Virtual Router Redundancy Protocol (*VRRP*) for IPv6 provides a much faster switchover to an alternate default router than can be obtained using standard neighbor discovery (ND) procedures.

NETBIOS

Network Basic Input / Output System (NETBIOS)

NIP

This set of fields are a vector of N IP unicast addresses, where the value N corresponds to the Number or Sources (N) field.

NMS

Network Management System (NMS)

NO

NO (normally open) is an open circuit not creating a path for the current.

NPS

Network Policy Server (NPS)

NSSA

Not-so-stubby Area (NSSA)

NTP

Network Time Protocol (NTP)

NVP

Network Voice Protocol (NVP)was a pioneering computer network protocol for transporting human speech over packetized communications networks. It was an early example of Voice over Internet Protocol technology.

NVRAM

Non-volatile random-access memory (NVRAM) is random-access memory that retains data without applied power. This is in contrast to dynamic random-access memory (DRAM) and static random-access memory (SRAM), which both maintain data only for as long as power is applied, or such forms of memory as magnetic tape, which cannot be randomly accessed but which retains data indefinitely without electric power.

OID

Object IDentifier

OSPF

Open Shortest Path First routing protocol

OUI

organization unique identifiers (OUI)s. LLDP enables defining optional *TLV* units by using organization unique identifiers (OUIs) or organizationally-specific TLVs. An OUI identifies the category for a *TLV* unit depending on whether the OUI follows the IEEE 802.1 or IEEE 802.3 standard.

P2P

Peer-to-peer (P2P) transparent clock for Precision Time Protocol (PTP).

PAE

Port Access Entity (PAE). 802.1X-2001 defines two logical port entities for an authenticated port—the "controlled port" and the "uncontrolled port". The controlled port is manipulated by the 802.1X PAE (Port Access Entity) to allow (in the authorized state) or prevent (in the unauthorized state) network traffic ingress and egress to/from the controlled port. The uncontrolled port is used by the 802.1X PAE to transmit and receive EAPOL frames.

PAP

Password Authentication Protocol (PAP) is a password-based authentication protocol used by Point to Point Protocol (PPP) to validate users. PAP stops working after establishing the authentication; thus, it can lead to attacks on the network.

PC

Personal Computer

PCB

Provider Core Bridge (PCB) or S-VLAN Bridge; PCB integrates only one S-VLAN component. It is capable of providing single service on a port.

PDU

A Protocol Data Unit (PDU) is a single unit of information transmitted among peer entities of a computer network. A PDU is composed of protocol-specific control information and user data.

P/E

Program/Erase (P/E). Writing a byte to flash memory involves two steps: Program and Erase (P/E). P/E cycles can serve as a criterion for quantifying the endurance of a flash storage device.

PEB

Provider Edge Bridge (PEB); Provider Edge Bridge integrates one S-VLAN component with zero or many C-VLAN components as well as integrates each C-VLAN (up to 4094 C-VLANs) individually with a different S-VLAN (up to 4094 S-VLANs).

PEM

PEM (originally “Privacy Enhanced Mail”) is the most common format for X.509 certificates, CSRs, and cryptographic keys. A PEM file is a text file containing one or more items in Base64 ASCII encoding, each with plain-text headers and footers (e.g. -----BEGIN CERTIFICATE----- and -----END CERTIFICATE-----). A single PEM file could contain an end-entity certificate, a private key, or multiple certificates forming a complete chain of trust. Most certificate files downloaded from SSL.com will be in PEM format

PEP

Provider Edge Port (PEP). The Customer Edge Port and each Provider Edge Port are treated as separate Bridge Ports by the spanning tree protocol. If the C-VLAN component connects to the S-VLAN component with a single Provider Edge Port, and the associated service instance supports no more than two customer interfaces, then all frames (including Spanning Tree BPDUs) addressed to the Bridge Group Address may be relayed between the two Ports of the C-VLAN component without modification. Otherwise, the Spanning Tree Protocol Entity shall execute the Rapid Spanning Tree Protocol (RSTP, Clause 17 of IEEE Std 802.1D), as modified by the provisions of this subclause.

PHB

PHB (Per Hop Behavior) is a term used in differentiated services (DiffServ) or multiprotocol label switching (MPLS). It defines the policy and priority applied to a packet when traversing a hop (such as a router) in a DiffServ network.

PHY

A PHY, an abbreviation for "physical layer", is an electronic circuit, usually implemented as an integrated circuit, required to implement physical layer functions of the OSI model in a network interface controller.A PHY connects a link layer device (often called MAC as an acronym for medium access control) to a physical medium such as an optical fiber or copper cable. A PHY device typically includes both physical coding sublayer (PCS) and physical medium dependent (PMD) layer functionality.[16]-PHY may also be used as a suffix to form a short name referencing a specific physical layer protocol, for example M-PHY. .

PIM

Protocol-Independent Multicast (PIM) is a family of multicast routing protocols for Internet Protocol (IP) networks that provide one-to-many and many-to-many distribution of data over a LAN, WAN or the Internet. It is termed protocol-independent because PIM does not include its own topology discovery mechanism, but instead uses routing information supplied by other routing protocols. PIM is not dependent on a specific unicast routing protocol; it can make use of any unicast routing protocol in use on the network. PIM does not build its own routing tables. PIM uses the unicast routing table for reverse-path forwarding.
There are four variants of PIM:

- PIM Sparse Mode (PIM-SM) explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source. PIM-SM generally scales fairly well for wide-area usage.
- PIM Dense Mode (PIM-DM) uses dense multicast routing. It implicitly builds shortest-path trees by flooding multicast traffic domain wide, and then pruning back branches of the tree where no receivers are present. PIM-DM is straightforward to implement but generally has poor scaling properties. The first multicast routing protocol, DVMRP used dense-mode multicast routing. See the PIM Internet Standard RFC 3973.
- Bidirectional PIM (Bidir-PIM) explicitly builds shared bi-directional trees. It never builds a shortest path tree, so may have longer end-to-end delays than PIM-SM, but scales well because it needs no source-specific state. See Bidirectional PIM Internet Standard RFC 5015, 70–73 .
- PIM Source-Specific Multicast (PIM-SSM) builds trees that are rooted in just one source, offering a more secure and scalable model for a limited number of applications (mostly broadcasting of content). In SSM, an IP datagram is transmitted by a source S to an SSM destination address G, and receivers can receive this datagram by subscribing to channel (S,G). See informational RFC 3569

Bidirectional (Bidir) *PIM*

Bidirectional PIM (Bidir-PIM) explicitly builds shared bi-directional trees. It never builds a shortest path tree, so may have longer end-to-end delays than PIM-SM, but scales well because it needs no source-specific state. See Bidirectional PIM Internet Standard RFC 5015, 70–73.

PIM-DM

Protocol-Independent Multicast Dense Mode PIM-DM) uses dense multicast routing. It implicitly builds shortest-path trees by flooding multicast traffic domain wide, and then pruning back branches of the tree where no receivers are present. PIM-DM is straightforward to implement but generally has poor scaling properties.

PIM-SM

Protocol-Independent Multicast Sparse Mode (PIM-SM) explicitly builds unidirectional shared trees rooted at a rendezvous point (RP) per group, and optionally creates shortest-path trees per source. PIM-SM generally scales fairly well for wide-area usage.

PING

Packet INternet Groper (PING or Ping)

PIP

Provider Instance Port (PIP)

PIR

Peak Information Rate (PIR) is a burstable rate set on routers and/or switches that allows throughput overhead. Related to committed information rate (CIR) which is a committed rate speed guaranteed/capped.

PMBR

PIM Multicast Border Router (PMBR)

PMTU

Path Maximum Transmission Unit (PMTU)

PNAC

Port Based Network Access Control (PNAC), or 802.1X, authentication requires a client, an authenticator, and an authentication server. The client is a device that wants to connect to the network.

PNP

Provider Network Ports (PNP)

PoE

Power over Ethernet (PoE) is distributing power over an Ethernet network. Because the power and signal are on the same cable, PoE enables remote network devices such as ceiling-mounted access points, surveillance cameras and LED lighting to be installed far away from AC power sources.

PPP

Point-to-Point Protocol (PPP); The user or machine sends a request to a Network Access Server (NAS) to gain access to a particular network resource using access credentials. The credentials are passed to the NAS device via the data link layer (L2) protocol—for example, Point-to-Point Protocol (PPP) in the case of many dial up or DSL providers or posted in an HTTPS secure web form.

PPVID

Port and Protocol *VLAN* ID (PPVID)

PS

Power Supply

PTP

Precision Timing Protocol

PVID

Port *VLAN* ID (PVID)

PVLAN

Private VLAN (PVLAN); Private VLAN, also known as port isolation, is a technique in computer networking where a VLAN contains switch ports that are restricted such that they can only communicate with a given uplink. The restricted ports are called private ports

PVRST

Per VLAN Rapid Spanning-Tree

PVRSTP

Per VLAN Rapid Spanning-Tree Protocol

PW

An Ethernet pseudowire (PW) is used to carry Ethernet/802.3 Protocol Data Units (PDUs) over an MPLS network. See RFC 4448 for details.

Q-in-Q

802.1Q tunneling (Q-in-Q) is a technique often used by Ethernet providers as a layer 2 VPN for customers. During 802.1Q (or dot1q) tunneling, the provider will put an 802.1Q tag on all the frames that it receives from a customer with a unique VLAN tag. By using a different VLAN tag for each customer we can separate the traffic from different customers and also transparently transfer it throughout the service provider network.

QoS

Quality of Service (QoS) refers to traffic prioritization and resource reservation control mechanisms rather than the achieved service quality. QoS defines the ability to provide different priorities to

different applications, users, or data flows or the ability to guarantee a certain level of performance to a data flow.

QRV

Querier's Robustness Variable (QRV).

RADIUS

Remote Authentication Dial-In User Service

RAM

Random-access memory (RAM) is a form of computer memory that can be read and changed in any order, and typically is used to store working data and machine code.

RARP

The Reverse Address Resolution Protocol (RARP) is an obsolete computer communication protocol used by a client computer to request its Internet Protocol (IPv4) address from a computer network, when all it has available is its link layer or hardware address, such as a MAC address.

RBAC

Role Based Authentication (RBAC)

RED

Random early detection (RED) is where a single queue may have several different sets of queue thresholds.

RIP

RIP (Routing Information Protocol) sends routing-update messages at regular intervals and when the network topology changes. When a router receives a routing update that includes changes to an entry, it updates its routing table to reflect the new route. The metric value for the path is increased by 1, and the sender is indicated as the next hop. RIP routers maintain only the best route (the route with the lowest metric value) to a destination. After updating its routing table, the router immediately begins transmitting routing updates to inform other network routers about the change. These updates are sent independently of the regularly scheduled updates that RIP routers send. RIP uses a hop count as a way to determine network distance. Each host with a router in the network uses the routing table information to determine the next host to route a packet for a specified destination.

RMON

Remote network monitoring (RMON) is the process of monitoring network traffic on a remote Ethernet segment for detectingnetwork issues such as dropped packets, network collisions, and traffic congestion

RP

Rendezvous point (RP)

RPF

RPF stands for Reverse Path Forwarding. PIM uses reverse-path forwarding (RPF) to prevent multicast routing loops by leveraging the unicast routing table on the virtual router. When the virtual router receives a multicast packet, it looks up the source of the multicast packet in its unicast routing table to see if the outgoing interface associated with that source IP address is the interface on which that packet arrived. If the interfaces match, the virtual router duplicates the packet and forwards it out the interfaces toward the multicast receivers in the group. If the interfaces don't match, the virtual router drops the packet. *This is called a RPF failure.*

RPT

Root Part Tree (RPT)

RRD

Route Redistribution (RRD)

RSVP

Resource Reservation Protocol (RSVP) is a transport layer protocol designed to reserve resources across a network using the integrated services model. RSVP operates over an IPv4 or IPv6 and provides receiver-initiated setup of resource reservations for multicast or unicast data flows.

RS-232

RS-232 is a short range connection between a single host and a single device (such as a PC to a modem) or another host (such as a PC to another PC). The standard uses a single TX line, a single RX line, numerous modem handshaking lines and a ground line with the option of DB9 and DB25 connectors. A minimal 3-wire RS-232 connection consists only the TX, RX, and ground lines, but if flow control is required a minimal 5-wire RS-232 is used adding the RTS and CTS lines. The RS-232 standard has been commonly used in computer serial ports and is still widely used in industrial communication devices.

RS-422

RS-422 was meant as a replacement for RS-232 as it offered much higher speeds, better immunity to noise and allow for longer cable lengths making it better suited to industrial environments. The standard uses the same signals as the RS-232 standard, but used differential twisted pair so requires double the number of wires as RS-232. Connectors are not specified in the standard so block or DB connectors are commonly used. RS-422 cannot implement a true multi-point communications network since there can be only one driver on each pair of wires. However, one driver can fan-out to up to ten receivers.

RS-485

RS-485 standard addresses some short coming of the RS-422 standard. The standard supports inexpensive local networks and multidrop communication links, using the same differential signalling over twisted pairs as RS-422. The main difference being that in RS-485 drivers use three-state logic allowing the individual transmitters to deactivate while not transmitting, while RS-422 the transmitter is always active therefore holding the differential lines. Up to 32 devices can be connected, but with repeaters a network with up to 256 devices can be achieved. RS-485 can be used in a full-duplex 4-wire mode or half-duplex 2-wire mode. With long wires and high baud-rates it is recommended that termination resistors are used at the far ends of the network for signal integrity

RST

RST stands for reset. RST is one of the TCP flags.
TCP flags are various types of flag bits present in the TCP header. Each of them has its own significance. They initiate connections, carry data, and tear down connections. The commonly used TCP flags are SYN, ACK, RST, FIN, URG, PSH.

- SYN (synchronize): Packets that are used to initiate a connection.
- ACK (acknowledgment): Packets that are used to confirm that the data packets have been received, also used to confirm the initiation request and tear down requests.
- RST (reset): Signify the connection is down or maybe the service is not accepting the requests.

- FIN (finish): Indicate that the connection is being torn down. Both the sender and receiver send the FIN packets to gracefully terminate the connection.
- PSH (push): Indicate that the incoming data should be passed on directly to the application instead of getting buffered.
- URG (urgent): Indicate that the data that the packet is carrying should be processed immediately by the TCP stack.

RSTP

Rapid Spanning-Tree Protocol

RTS

Request to Send (RTS)/CTS Flow Control is another flow control mechanism that is part of the RS232 standard.

RX

Receive

SA

Security Associations (SA). A SA is a relationship between two or more entities that describes how the entities will utilize security services to communicate securely. In endpoint-to-endpoint Transport Mode, both end points of the IP connection implement IPSec.

SEM

State Event Machines (SEM)

SFP

SFP (Small Form-factor Pluggable) is a small transceiver that plugs into the SFP port of a network switch and connects to fibre channel and gigabit Ethernet (GbE) optical fiber cables at the other end. The SFP converts the serial electrical signals to serial optical signals and vice versa. SFP modules are hot swappable and contain ID and system information for the switch.

SFTP

SSH File Transfer Protocol (SFTP)

SHA

Secure Hash Algorithm is the name of a series of hash algorithms.
A hash function provides encryption using an algorithm and no key. A variable-length plaintext is “hashed” into a (typically) fixed-length hash value (often called a “message digest” or simply a “hash”). Hash functions are primarily used to provide integrity; the hash of a plaintext changes, the plaintext itself has changed.
Common older hash functions include Secure Hash Algorithm 1 (SHA-1), which creates a 160-bit hash and Message Digest 5 (MD5), which creates a 128-bit hash.

SIP

Session Initiation Protocol (SIP) is mostly well known for establishing voice and video calls over the Internet. To initiate such sessions, SIP uses simple request and response messages. For example, the INVITE request message is used to invite a user to begin a session and ACK confirms the user has received the request. The response code 180 (Ringing) means the user is being alerted of the call and 200 (OK) indicates the request was successful. Once a session has been established, BYE is used to end the communication.

SISP

Switch Instance Shared Port (SISP)

SLA

Service-level agreements (SLA).

SLIP

Serial Line Internet Protocol (SLIP); SLIP is the predecessor protocol of Point-to-Point Protocol (PPP). SLIP does not provide authentication, is a static IP addressing assignment, and data is transferred in synchronous form.

SM

State Machine

SNAT

Static Network Address Translation (SAT, SNAT) performs one-to-one translation of internal IP addresses to external ones.

SNMP

Simple Network Management Protocol

SNTP

Simple Network Time Protocol (SNTP)

SPT

Shortest path tree (SPT) is used for multicast transmission of packets with the shortest path from sender to recipients.

SR

State Refresh (SR) message. For a given (S,G) tree, SR messages will be originated byall routers that use an interface directly connected to the source as the RPF interface for the source. Ref: IETF “State Refresh in PIM-DM”

SRM

State Refresh Message (SRM). For a given (S,G) tree, SRM will be originated byall routers that use an interface directly connected to the source as the RPF interface for the source. Ref: IETF “State Refresh in PIM-DM”

SSD

SSD (Solid State Drive) is an all-electronic, non-volatile random access storage drive.

SSH

(Secure SHell) is a security protocol for logging into a remote server. SSH provides an encrypted session for transferring files and executing server programs on all platforms. Also serving as a secure client/server connection for applications such as database access and email, SSH supports a variety of authentication methods.

SSL

Secure Sockets Layer

SSM

Source-Specific Multicast (SSM)

SST

Single Spanning Tree (SST); SST is formed in either of the following situations:

- A switch running STP or RSTP belongs to only one spanning tree.

- An MST region has only one switch.

STP

Spanning Tree Protocol (STP) is a Layer 2 protocol that runs on bridges and switches. The specification for STP is IEEE 802.1D. The main purpose of STP is provide path redundancy while preventing undesirable loops in the network.

SVL

Shared VLAN Learning (SVL)

S-VLAN

Stacked VLAN (S-VLAN)

TAC

Taxonomy Access Control (TAC) allows the user administrator to control access to nodes indirectly by controlling which roles can access which categories.

TACACS

Terminal Access Controller Access-Control System

TAI

International Atomic Time (TAI); if the port is in the master state, the local clock is synchronized to an external source of time traceable to TAI (International Atomic Time) and UTC (Universal Coordinated Time) such as GPS (Global Positioning System) system.

TB

Token Bucket (TB). The TB algorithm is based on an analogy of a fixed capacity bucket into which tokens, normally representing a unit of bytes or a single packet of predetermined size, are added at a fixed rate. When a packet is to be checked for conformance to the defined limits, the bucket is inspected to see if it contains sufficient tokens at that time. If so, the appropriate number of tokens, e.g. equivalent to the length of the packet in bytes, are removed ("cashed in"), and the packet is passed, e.g., for transmission. The packet does not conform if there are insufficient tokens in the bucket, and the contents of the bucket are not changed.

TC

TC (Topology Change); once the Root Bridge is aware of a change in the topology of the network, it sets the Topology Change (TC) flag on the sent BPDs.

TCN

TCN (Topology Change Notification), a kind of BPDU, is sent by bridges towards the root bridge to notify changes in the topology, such as port up or port down.

TCP

Transmission Control Protocol

TFTP

Trivial File Transfer Protocol

TLS

Transport Layer Security (TLS), the successor of the now-deprecated Secure Sockets Layer (SSL), is a cryptographic protocol designed to provide communications security over a computer network.

TLV

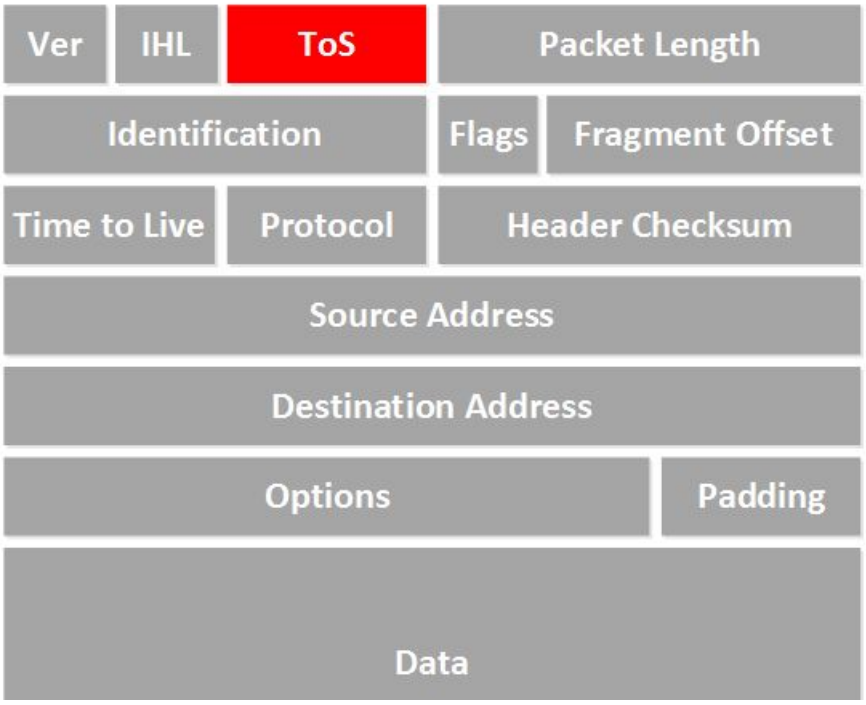
type, length, and value (TLV) traces

TN

Telnet (TN) is a networking protocol and software program used to access remote computers and terminals over the Internet or a TCP/IP computer network. Upon providing correct login and sign-in credentials, a user may access a remote system's privileged functionality. Telnet sends all messages in clear text and has no specific security mechanisms.

TOS

Type of Service (TOS). IP packets have a field called the Type of Service field (also known as the TOS byte).



TPID

Tag Protocol Identifier (TPID)

TTL

TTL (time to live). Under IP, TTL is an 8-bit field. In the IPv4 header, TTL is the 9th octet of 20. In the IPv6 header, it is the 8th octet of 40. The maximum TTL value is 255, the maximum value of a single octet. A recommended initial value is 64.

TX

Transmit

UAP

Uplink Access Port (UAP); when a tagged LLDP is enabled, the LLDP packets with destination address as 'nearest bridge address (01-80-c2-00-00-0E)' will be replicated for all S-Channels emulated over that UAP.

UART

UART (Universal Asynchronous Transmitter Receiver) is the most common protocol used for full-duplex serial communication.It is a single LSI (large scale integration) chip designed to perform asynchronous communication. This device sends and receives data from one system to another system.

UDP

User Datagram Protocol

UFD

Uplink failure detection (UFD)

URM

Unified Route Map (URM)

USM

USM stands for User based Security Model; USM (User based Security Model) and VACM (View-based Access Control Model) are the main features added as a part of the SNMPv3 specification. USM provides both encryption and authentication of the SNMP PDUs, while VACM specifies a mechanism for defining access policies for different users with different MIB trees.

UTC

Coordinated Universal Time (UTC); If the port is in the master state, the local clock is synchronized to an external source of time traceable to TAI (International Atomic Time) and UTC (Universal Coordinated Time) such as GPS (Global Positioning System) system.

UTP

Unshielded Twisted Pair (UTP) is a pair of wires that are twisted around each other to minimize interference. Ethernet cables are common example of UTP wires.

UUID

A Universally Unique IDentifier (UUID) is a 128-bit domain UUID unique to a MRP domain/ring. All MRP instances belonging to the same ring must have the same domain ID.

VACM

VACM stands for View-based Access Control Model); USM (User based Security Model) and VACM (View-based Access Control Model) are the main features added as a part of the SNMPv3 specification. USM provides both encryption and authentication of the SNMP PDUs, while VACM specifies a mechanism for defining access policies for different users with different MIB trees.

Varbind

A Variable Binding (Varbind) represents a set of Oid/Value pairs. Individual Variable Bindings are stored in the Vb class. Individual Variable Bindings are stored in the Vb class.
Create a variable binding and add the Object identifier in string format:
Vb vb = new Vb("1.3.6.1.2.1.1.1.0")
Create a variable binding and add the Object identifier in Oid format:
Oid oid = new Oid("1.3.6.1.2.1.1.1.0");
Vb vb = new Vb(oid);

VFI

Virtual Forwarding Interface (VFI)

VID

Management VLAN ID (VID)

VINES

Virtual Integrated Network Service (VINES)

VLAN

Virtual Local Area Network (VLAN) is a logical subgroup within a local area network that is created via software rather than manually moving cables in the wiring closet.

VPN

Virtual Private Network (*VPN*)

VRF

Virtual Routing and Forwarding (VRF). In IP-based computer networks, VRF is a technology that allows multiple instances of a routing table to co-exist within the same router at the same time. One or more logical or physical interfaces may have a VRF and these VRFs do not share routes; therefore, the packets are only forwarded between interfaces on the same VRF. VRFs are the TCP/IP layer 3 equivalent of a VLAN. Because the routing instances are independent, the same or overlapping IP addresses can be used without conflicting with each other.

VRRP

VRRP (Virtual Router Redundancy Protocol) is an election protocol that dynamically assigns responsibility for one or more virtual router(s) to the VRRP router(s) on a LAN, allowing several routers on a multi-access link to utilize the same virtual IP address. A VRRP router is configured to run the VRRP protocol in conjunction with one or more other routers attached to a LAN. In a VRRP setup, one router is elected as the virtual router master, and the other routers are acting as backups in case of the failure of the virtual router master. VRRP is designed to eliminate the single point of failure inherent in the static default routed environment

VSA

Vendor Specific Attribute (VSA)

WAN

A wide area network is a telecommunications network that extends over a large geographic area for the primary purpose of computer networking.

Web UI

Web User Interface (Web UI) is a control panel in a device presented to the user via the Web browser. Network devices such as gateways, routers, and switches typically have such control panel that is accessed by entering the IP address of the device into a Web browser in a computer on the same local network.

WRED

WRED (Weighted Random Early Detection) is a queueing discipline for a network scheduler suited for congestion avoidance. It is an extension to random early detection (RED) where a single queue may have several different sets of queue thresholds.

WRR

Weighted Round Robin (WRR) is one of the scheduling algorithms used by the device. In WRR, there is a number of queues and to every queue is assigned weight (*w*). In a classical WRR, the scheduler cycles over the queues, and when a queue with weight *w* is visited, the scheduler can send consequently a burst of up *to w* packets. This works well for packets with the same size.

XNS

Xerox Network Systems (XNS)

Contents

INTRODUCTION

1. Introduction

The IS5Com *STP* (Spanning Tree Protocol) provides path redundancy by eliminating undesirable bridge loops in the network.

This chapter describes the purpose and scope of this document and lists the definitions / acronyms, conventions used in this document.

1.1. Purpose and Scope

This document describes the configuration of spanning tree on the switch running IS5Com *ISS* to eliminate loops in the network topology. As a prerequisite, the reader is expected to have a basic knowledge of the protocol as a prerequisite.

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]`

Convention	Usage	DESCRIPTION
{ }	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`

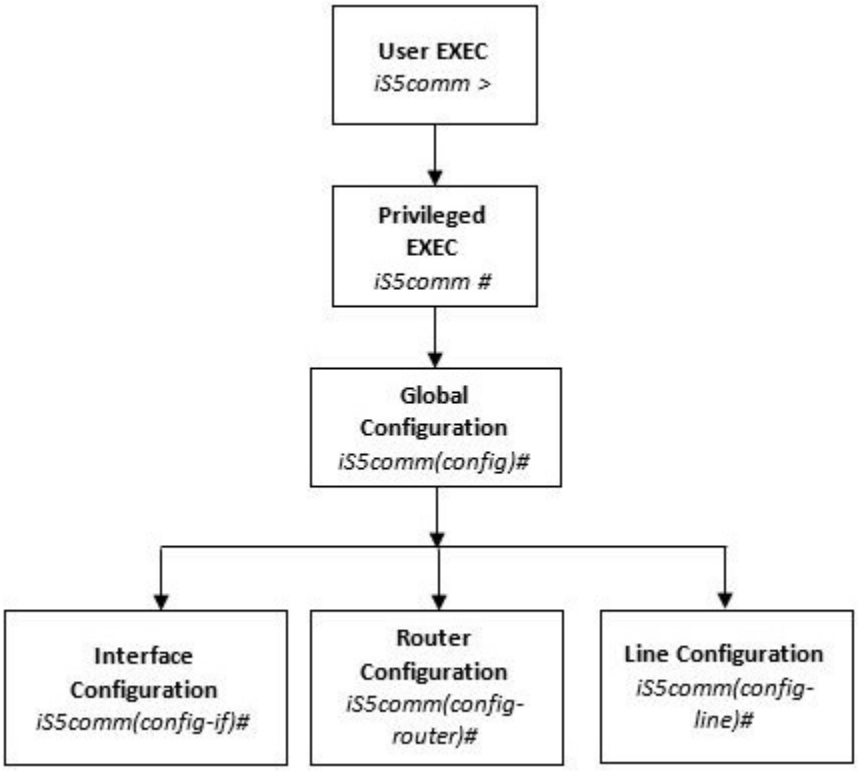
Note	Notes	**NOTE:** All commands are case-sensitive

1.3. CLI Command Modes

The *CLI* Modes are as follows.

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 VLAN 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.

MRP Interface Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(config-mrp)#`	The Global Configuration mode command `mrp ringid 1`s used to enter the MRP Interface Configuration Mode.	To return from the MRP Interface Configuration mode to Global Configuration Mode, the command `exit` is used. To exit from the MRP 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 **`(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

Command	First Param	Guest	Tech	Admin	Description
	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
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

Command	First Param	Guest	Tech	Admin	Description
	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
	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

Command	First Param	Guest	Tech	Admin	Description
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
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					

Command	First Param	Guest	Tech	Admin	Description
	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
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.

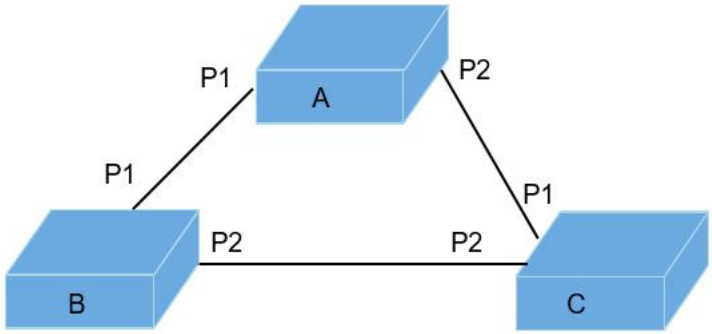
- bridge-mode
- enableuser
- mst
- password
- traffic

CONFIGURING STP

2. Configuring STP

The following sections describe the configuration of the *STP* (Spanning Tree Protocol).

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 *LAN*s and allows them 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* (Spanning Tree Protocol) is used in the IS5Com *ISS* 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, IS5Com *ISS* provides also support for *RSTP* (Rapid Spanning Tree Protocol). The operation of provides for rapid recovery of connectivity following a failure of a Bridge/ Bridge Port or a *LAN*.

To isolate link fluctuations specific to a particular VLAN segment(s) and provide load balancing, IS5Com *ISS* provides support for Multiple Spanning Trees. These can be configured on a per VLAN basis or multiple VLANs can be mapped to the same spanning tree.

STP calculates the best loop-free path by assigning port roles to the ports of a switch as follows:

- **Root**—a 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.

A stable, active spanning tree topology of a switched network is determined by the following elements.

- Bridge ID (Switch Priority and *MAC* address)
- Path Cost to the Root Switch
- Port Identifier (Port priority and the Port Number)

When switches in a network come up, every switch assumes to be the Root Bridge and starts sending configuration messages (or special types of *BPDU* (bridge protocol data unit)) through all its ports. *BPDU*s are used to communicate and compute the spanning tree topology. These *BPDU*s contain the following information:

- 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 that LAN from which the inferior information was received, it 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 spanning tree protocol can be in one of the following states.

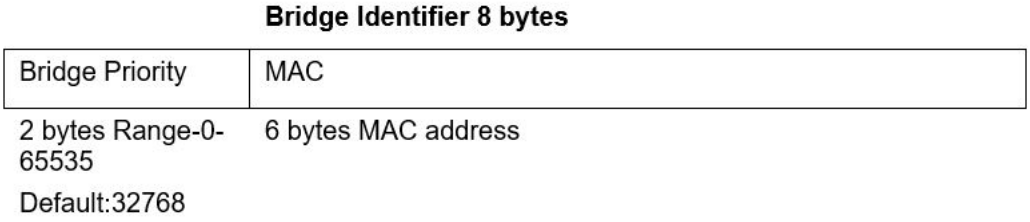
- **Blocking**—the interface in this state discards the frames and does not learn the *MAC* addresses.
- **Listening**—this is the first state that a port can transition to after blocking. The interface enters this state when spanning tree decides that the interface must participate in frame forwarding.
- **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

Every switch has a unique bridge identifier (bridge ID), which 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



2.3. Election of Root Switch

All switches in the Layer 2 network participating in *STP* gather information on other switches in the network through an exchange of data messages called *BPDU*s. The exchange of *BPDU*s 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 a Root Switch. If all switches are configured with the default priority (32768), the switch with the lowest *MAC* address becomes the Root Switch. The switch's 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.

*BPDU*s contain information about the sending switch and its ports, including switch's and port's *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.

CONFIGURING RSTP

3. Configuring RSTP

The following sections describe the configuration of the Rapid Spanning Tree Protocol (*RSTP*).

3.1. RSTP Description

The Rapid Spanning Tree Protocol (*RSTP*) Module is based on the IEEE 802.1D-2004 rapid reconfiguration. The existing *STP* 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.

3.2. Port States

Table 1: Port States

STP (802.1D) Port State	RSTPPort 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

3.3. Port Roles

Table 2: Port States (Sheet 1 of 2)

Port Role	Description
Root	Provides the best path to the root. This is the port that receives the best *BPDU* on a bridge

Table 2: Port States (Continued) (Sheet 2 of 2)

Port Role	Description
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 *BPDU*s 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 802.1D.
Back-up	A port blocked since another port receives superior information from the same bridge. This port also corresponds to the blocking state of 802.1D.

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.

3.4. Rapid Convergence

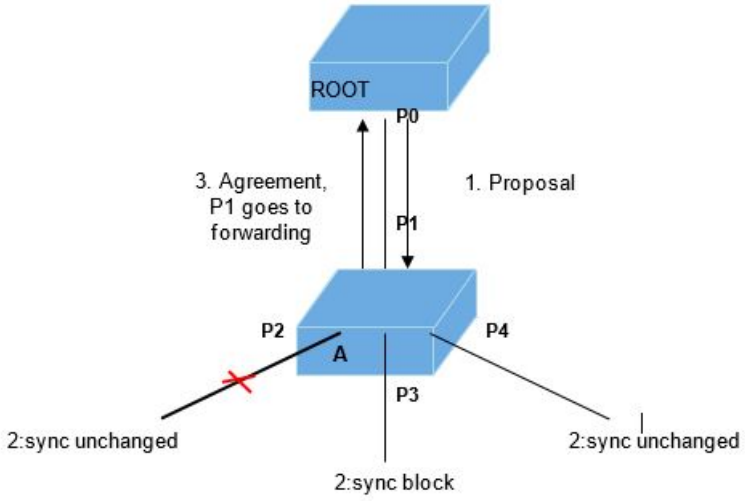
Faster convergence compared to legacy spanning tree algorithm is the most important feature in *RSTP*. *RSTP* relies on two new variables for achieving this.

- **Edge Port**—ports that are directly connected to end stations cannot create bridging loops and hence can rapidly transition to forwarding skipping the learning and listening states. When the link toggles on an edge-port, then the topology-change is not triggered. Whenever a *BPDU* is received on an edge port, it loses its edge port status and becomes a normal spanning tree port. IS5Com *RSTP* uses portfast keyword for edge port configuration.
- **Link Types**—*RSTP* can achieve 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 will be assumed to be point-to-point, while a half-duplex port will be considered as a shared port by default. This automatic link type setting can be overridden by explicit configuration.

3.5. 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 *RSTP*, such port corresponds to a designated role and blocking state. The figure below illustrates the rapid transition of a port to forwarding state.

Figure 1: Proposal Agreement Handshake



P0: Designated port

P1: New root port

P2: Alternate port

P3: Designated port

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. When a designated port is in discarding or learning state (and only in this case), it sets the proposal bit on the sent *BPDU*. This happens for port P0 of the root bridge, as shown in step 1 of the above shown figure. Because 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 (step 2 of the diagram above), Switch A just needs to block port P3, assigning it the discarding state. If all ports are in-sync, Switch A can unblock its newly selected root port P1 and reply 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, it can immediately transition to forwarding. Port P3 which was left in a designated discarding state after the sync, in the next step, is exactly in the same state as port P0 was in Step 1. It then starts proposing to its neighbor, attempting to quickly transition to forwarding. This handshake mechanism propagates quickly towards the edge of the network and rapidly restores connectivity after a change in the topology.

3.6. 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 bit on the *BPDU*s which are 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 forwarding state cause a topology change. This means that a loss of connectivity is not considered as a topology change any more, contrarily to 802.1D (that is, a port moving to blocking does no longer generates a *TC*). When a *RSTP* bridge detects a topology change, the following happens:

- It starts the *TC* While timer with a value equal to twice the hello time for all its non-edge designated ports and for its root port if necessary.
- It flushes the MAC addresses associated with all non-edge designated ports.
- As long as the *TC* While timer is running on a port, the *BPDU*s sent out of that port have the *TC* bit set. The *BPDU*s are also sent on the root port while the timer is active.

3.7. Default Configurations

Table 3: Default Configurations

Feature	Default Setting
Spanning Tree mode	*RSTP*
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 (for RSTP, the default value is 65535)

3.8. Setting Spanning Tree Compatibility to STP

When the switch comes up, spanning tree is enabled by default with *MSTP* operating in the switch.

1. Execute the following commands in the switch to set the spanning tree compatibility version for *STP*.

   FOR EXAMPLE: Type the following:

– Enter the Global Configuration Mode in ISS1.

```
iS5comm# configure terminal
```

– Set the compatibility version for the spanning tree protocol.

```
iS5comm(config)#spanning-tree compatibility stp
```

– Return to the Privileged EXEC mode.

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

– View the spanning tree mode changes as per the input by executing the following show command.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:05   Cost       0
Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning Tree  Protocol Enabled.
MST00 is executing the stp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
Address  00:01:02:03:04:05
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Designated Forwarding   65535    128    SharedLan
```

– Execute the no spanning-tree compatibility from Global Configuration mode command to set the default compatibility version for spanning tree protocol.

```
iS5comm(config)#no spanning-tree compatibility stp
```

3.9. Configuring Spanning Tree Bridge Priority

Refer to Figure Spanning Tree Topology. All switches must be in default configurations. After the topology stabilizes, switch A is elected as the 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 in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Set the priority for the spanning tree protocol.

```
iS5comm(config)# spanning-tree priority 4096
```

For priority, the range is 0 to 61440, in increments of 4096. The default is 32768. The lower the number, the more likely 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.

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

```
iS5comm# show spanning-tree
```

In Switch A

```
Root Id          Priority   32768
Address    00:03:02:03:04:01
 Cost       200000
 Port       2 [Gi0/2]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Alternate  Forwarding   200000   128    SharedLan
Gi0/2   Root       Forwarding   200000   128    SharedLan
```

In Switch B

```
Root Id          Priority 4096
Address    00:03:02:03:04:01
 Cost       200000
 Port       2 [Gi0/2]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
```

```
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:02:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Designated Forwarding   200000   128    SharedLan
Gi0/2   Root       Forwarding   200000   128    SharedLan
```

In Switch C

```
Root Id         Priority 4096
Address    00:03:02:03:04:01
 Cost       0
 Port       0 [0]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority 4096
 Address  00:03:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Designated Forwarding   200000   128    SharedLan
Gi0/2   Designated Forwarding   200000   128    SharedLan
```

– Execute the no spanning-tree priority from the Global Configuration mode command to set the Priority to its default value.

```
iS5comm(config)#no spanning-tree priority
```

3.10. Configuring Spanning Tree Path Cost

Refer to Figure Spanning Tree Topology. All switches are configured for *STP* compatible using spanning-tree compatibility stp in Global Configuration mode. 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 it is in discarding state.

CONTEXT:

When a loop occurs in the network topology, spanning tree protocol may use path cost to determine the spanning tree states of the ports. Path cost is obtained from the speed of the interface. A user can configure lower path cost for an interface, if the port needs to be selected first or the user can configure higher path cost if the port needs to be selected last for putting it to 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 lowest numbered port is first put into forwarding state by spanning tree.

1. Execute the following commands in the Switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

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

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

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

   – Configure the cost for the interface.

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

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

   ```
   iS5comm# show spanning-tree
   ```

   In Switch A

   ```
   Root Id         Priority   32768
   Address 00:01:02:03:04:01
    Cost       200000
    Port       0 [0]
   Max age 20 sec 0 cs, forward delay 15 sec 0 cs
    Hello Time 2 sec 0 cs

   MST00
   Spanning Tree Protocol Enabled.
   MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
   Bridge Id   Priority  32768
    Address  00:01:02:03:04:01
    Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
   ```

```
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Designated Forwarding   200000   128    SharedLan
Gi0/2   Designated Forwarding   200000   128    SharedLan
```

In Switch B

```
Root Id         Priority 4096
Address    00:03:02:03:04:01
 Cost       200000
 Port 1 [Gi0/1]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:02:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Root       Forwarding   200000   128    SharedLan
Gi0/2   Alternate  Forwarding   200000   128    SharedLan
```

In Switch C

```
Root Id         Priority 32768
Address    00:03:02:03:04:01
 Cost       2000
 Port 1 [Gi0/1]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority 4096
 Address  00:03:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
```

```
----    ----       -----        ----    ----   ------
Gi0/1   Root       Forwarding   200000  128    SharedLan
Gi0/2   Designated Forwarding   200000  128    SharedLan
```

– Execute the spanning-tree cost Interface Configuration mode command to set the default value of the Spanning Tree Path Cost.

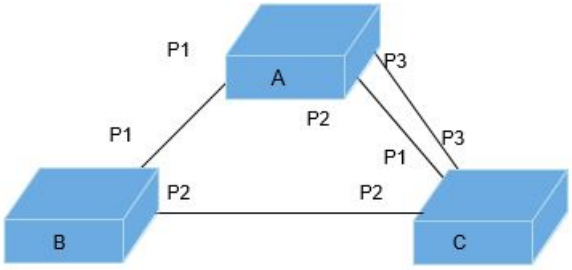
```
iS5comm(config-if)#no spanning-tree cost
```

3.11. Configuring Spanning Tree Port Priority

Refer to Figure Spanning Tree Topology. All switches are configured for *STP* compatible using the "spanning-tree compatibility stp" Global Configuration mode command. After the topology stabilizes, Switch A is elected as Root and all ports of all switches except Ports 2 and 3 (alternate, discarding) of Switch C are in forwarding state.

CONTEXT:

Figure 2: Spanning Tree Topology for Configuring Port Priority



Switch A: VLAN 1 -10.0.0.1/255.0.0.0

Switch B: VLAN 1 – 10.0.0.2 /255.0.0.0

Switch C: VLAN 1 – 10.0.0.3/255.0.0.0

When a loop occurs in a network topology, spanning tree may use the value of port-priority of the ports to decide the port that must be put in the forwarding state.

Port priority is used to determine the topology only if the loop in the network cannot be resolved using the Bridge IDs or path-cost.

If higher priority (lower numerical value) is assigned to a port, it goes to forwarding first and when lower priority (higher numerical value) is assigned to a port, it goes to forwarding last. If all ports have same priority values, spanning tree puts the lowest numbered interface to forwarding and blocks all other interfaces

1. Execute the following commands in the Switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

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

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

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

– Configure the port priority for spanning tree.

```
iS5comm(config-if) # spanning-tree port-priority 32
```

For priority, the range is 0 to 240 in increments of 16. The default is 128. The lower the number, the higher the priority.

Valid priority values are 0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, and 240. All other values are rejected.

NOTE: Observation after configuring the Port Priority for Port 3 in Switch A: Ports 1, 2 of Switch B are the Alternate Ports and Port 3 is the root port.

– Return to the Privileged EXEC mode.

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

– View the spanning tree properties by executing the following show command.

```
iS5comm# show spanning-tree
```

In Switch A

```
Root Id         Priority   32768
Address 00:01:02:03:04:01
 Cost       200000
 Port       0 [0]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role        State        Cost     Prio   Type
----    ----        -----        ----     ----   ------
Gi0/1   Designated  Forwarding   200000   128    SharedLan
Gi0/2   Designated  Forwarding   200000   128    SharedLan
Gi0/3   Designated  Forwarding   200000   32     SharedLan
```

In Switch B

```
Root Id         Priority 32768
Address    00:03:02:03:04:01
 Cost       200000
 Port 1 [Gi0/1]
```

```
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:02:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role        State        Cost     Prio   Type
----    ----        -----        ----     ----   ------
Gi0/1   Root        Forwarding   200000   128    SharedLan
Gi0/2   Designated  Forwarding   200000   128    SharedLan
```

In Switch C

```
Root Id         Priority 32768
Address    00:03:02:03:04:01
 Cost       2000
 Port 2 [Gi0/2]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
 Hello Time 2 sec 0 cs

MST00
Spanning Tree Protocol Enabled.
MST000 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority 4096
 Address  00:03:02:03:04:01
 Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role        State        Cost     Prio   Type
----    ----        -----        ----     ----   ------
Gi0/1   Alternate   Forwarding   200000   128    SharedLan
Gi0/2   Alternate   Forwarding   200000   128    SharedLan
Gi0/3   Root        Forwarding   200000   128    SharedLan
```

– Execute the no spanning-tree port-priority Interface configuration command to set the Spanning Tree Port Priority to its default value.

```
iS5comm(config-if)#no spanning-tree port-priority
```

3.12. Configuring Spanning Tree Link Type

If a port is configured as point-to-point link and its port role is designated, then IS5Com *RSTP* negotiates a rapid transition to forwarding with the other port by using 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 state.

1. Execute the following commands in the Switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

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

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

   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)#end
   ```

   – View the spanning tree properties by executing the following show command.

   ```
   iS5comm# show spanning-tree detail
   Spanning tree Protocol Enabled.
   MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
   Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
   Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
   Configured Hello Time 2 sec 0 cs
   We are root of the spanning tree
   Current Root has priority 32768, address  00:01:02:03:04:01cost of root
   path is 0
   Number of Topology Changes 1, Time since topology Change 37 seconds ago
   Transmit Hold-Count 3
   Root Times : Max age 20 sec 0 cs     Forward delay
   15 sec 0 cs
   Port 1 [Gi0/1] of MST00 is Designated, Forwarding
   Gi0/1 is operating in the MSTP Mode
   Port path cost  200000, Port priority  128,
   Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
   Timers:Hello - 0,Forward Delay - 0,Topology Change - 2
   Designated root has priority 32768, address 00:01:02:03:04:01
   Designated Bridge has priority 32768, address 00:01:02:03:04:01
   ```

```
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
PortFast is disabled
Link type is point to Point
BPDUs : sent 35, received 53
Restricted Role is disabled.
Restricted TCN is disabled.
```

– Execute the no spanning-tree link-type Interface Configuration mode command to set the default link type for an Interface.

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

3.13. Configuring Spanning Tree Portfast

CONTEXT:

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

A switch can be configured to automatically detect the presence of another switch connected to one of its port. If a switch receives configuration *BPDU*s from other switch, it can detect the presence of the other switch connected to one of its ports. On configuring a port as portfast, if the switch does not receive any *BPDU*s for a certain interval then Spanning Tree puts the port to forwarding state rapidly

1. Execute the following commands in the Switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

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

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

   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
   ```

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

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

   – Return to the Privileged EXEC mode.

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

   – View the spanning tree properties by executing the following show command.

```
iS5comm# show spanning-tree detail
Spanning tree Protocol Enabled.

MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 37 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay  15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 0,Forward Delay - 0,Topology Change - 2
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
PortFast is enabled
Link type is point to Point
BPDUs : sent 337, received 74
Restricted Role is disabled.
Restricted TCN is disabled
Port 2 [Gi0/2] of MST00 is Designated, Forwarding
Gi0/2 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.2. Port HelloTime  2 sec 0 cs,
Timers:Hello - 0,Forward Delay - 0,Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.2, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
PortFast is disabled
Link Type is Shared
```

```
BPDUs : sent 373, received 390
Restricted Role is disabled.
Restricted TCN is disabled.
```

– Execute the no spanning-tree portfast command in the Interface configuration mode to set the default spanning tree portfas for an Interface.

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

3.14. Configuring Spanning Tree Timers

CONTEXT:

The following table describes the Spanning Tree timers.

Table 4: Spanning Tree 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, when it is the Root of the spanning tree.
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 in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree timer.

   ```
   iS5comm(config)# spanning-tree forward-time 11
   ```

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

   – Return to the Privileged EXEC mode.

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

   – View the spanning tree properties of an interface.

   ```
   iS5comm# show spanning-tree
   Root Id         Priority   32768
   Address    00:01:02:03:04:01
   Cost       0
   Port       0 [0]
   This bridge is the root
   Max age 20 sec 0 cs, forward delay 15 sec 0 cs
   Hello Time 2 sec 0 cs
   ```

```
MST00
Spanning Tree  Protocol Enabled.
MST00 is executing the stp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
Address  00:01:02:03:04:05
Max age is 20 sec 0 cs, forward delay is 11 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role        State        Cost     Prio   Type
----    ----        -----        ----     ----   ------
Gi0/1   Designated  Forwarding   200000   128    P2P
Gi0/2   Designated  Forwarding   200000   128    SharedLan
```

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

```
iS5comm(config)#no spanning-tree forward-time
```

3.15. Displaying Spanning Tree Status

1. Execute the following commands to display the Spanning Tree Status.

   FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree active
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       0
Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning Tree  Protocol Enabled.
MST00 is executing the stp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
Address  00:01:02:03:04:05
Max age is 20 sec 0 cs, forward delay is 11 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role        State        Cost     Prio   Type
----    ----        -----        ----     ----   ------
Gi0/1   Designated  Forwarding   200000   128   P2P
Gi0/2   Designated  Forwarding  200000    128   SharedLan
```

```
iS5comm(config)#no spanning-tree detail
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 11 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 2, Time since topology Change 1024 seconds
ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 11 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 11 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 3
PortFast is enabled
Link type is point to Point
BPDUs : sent 632, received 74
Restricted Role is disabled.
Restricted TCN is disabled.
Gi0/1 is operating as Layer Two Gateway Port
MST00 PseudoRootId Priority 4096, MacAddress 00:01:02:03:04:01
bpdu-transmit disabled
bpdu-receive disabled
Port 2 [Gi0/2] of MST00 is Designated, Forwarding
Gi0/2 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.2. Port HelloTime  2 sec 0 cs,
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
```

```
Designated Port Id is 128.2, Designated pathcost is 0
Operational Forward delay 11 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
PortFast is disabled
Link Type is Shared
BPDUs : sent 668, received 685
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled

iS5comm(config)#no spanning-tree interface gigabitethernet 0/1
Instance  Role        State        Cost     Prio     type
--------  ----        -----        ----     ----     ----
MST00    Designated   Forwarding   200000   128.1    P2P

iS5comm(config)#no spanning-tree summary
Spanning Tree port pathcost method is Long
Spanning tree enabled protocol is MSTP

MST00 Port Roles and States
Port-Index  Port-Role    Port-State     Port-Status
----------  ---------    ----------     -----------
1           Designated   Forwarding     Enabled
2           Disabled     Discarding     Enabled
3           Disabled     Discarding     Enabled
4           Disabled     Discarding     Enabled
5           Disabled     Discarding     Enabled
6           Disabled     Discarding     Enabled
7           Disabled     Discarding     Enabled
8           Disabled     Discarding     Enabled
9           Disabled     Discarding     Enabled
10          Disabled     Discarding     Enabled
11          Disabled     Discarding     Enabled
12          Disabled     Discarding     Enabled
13          Disabled     Discarding     Enabled
14          Disabled     Discarding     Enabled
15          Disabled     Discarding     Enabled
16          Disabled     Discarding     Enabled
17          Disabled     Discarding     Enabled
```

```
18          Disabled     Discarding     Enabled
19          Disabled     Discarding     Enabled
20          Disabled     Discarding     Enabled
21          Disabled     Discarding     Enabled
22          Disabled     Discarding     Enabled
23          Disabled     Discarding     Enabled
24          Disabled     Discarding     Enabled
```

The following table shows the commands that display the Spanning Tree Status.

Table 5: Spanning Tree Status

Command	Purpose
show spanning-tree active	Displays the Bridge and details of the active (active ports are those ports that are participating in the spanning-tree) ports
show spanning-tree 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 interface interface-id	Displays spanning tree information for the specified interface.
show spanning-tree summary	Displays a summary of port states or displays the total lines of the STP state section.

CONFIGURING MSTP

4. Configuring MSTP

The following sections describe the configuration of the Multiple Spanning Tree Protocol (*MSTP*).

4.1. MSTP Description

IS5Com *MSTP* allows *VLAN*s to be grouped into a spanning-tree instance, with each instance having a spanning-tree topology independent of other spanning-tree instances. *VLAN*s can be grouped or associated to spanning tree instances. The topology of one instance can be independent of another instance. This provides multiple forwarding paths for data traffic and enables load balancing, thereby improving the fault tolerance of the overall network, since failure in one instance does not affect the other instances. This facilitates *VLAN* bridges to use multiple spanning trees, providing for traffic belonging to different *VLAN*s to flow over potentially different paths within the virtual bridged *LAN*.

4.2. How MSTP Works

MSTP divides an entire Layer 2 network into multiple *MST* regions, which are connected by a calculated *CST*. Inside an *MST* region, multiple spanning trees, called *MSTI*s, are calculated. Among these *MSTI*s, *MSTI*0 is the IST.

Like *STP*, *MSTP* uses configuration *BPDU*s to calculate spanning trees. An important difference is that an *MSTP BPDU* carries the *MSTP* configuration of the bridge from which the *BPDU* is sent.

MSTI calculation

Within an *MST* region, *MSTP* generates different *MSTI*s for different *VLAN*s based on the *VLAN*-to -instance mappings. For each spanning tree, *MSTP* performs a separate calculation process similar to spanning tree calculation in *STP*.

In *MSTP*, a *VLAN* frame is forwarded along the following paths:

- Within an *MST* region, the frame is forwarded along the corresponding *MSTI*.
- Between two *MST* regions, the frame is forwarded along the *CST*.

MST Region

Switches participating in *MST* instances must be constantly configured with the same *MST* configuration information. The collection of switches which have the same *MST* information form an *MST* region. This *MST* configuration determines the region to which each switch belongs. The configuration includes the

name of the region, the revision number, and the *MST VLAN*-to-instance assignment map. A region can have one member or multiple members with the same *MST* configuration. The number of *MST* regions in a network is not limited, but each region can support up to 16 spanning-tree instances. A *VLAN* can be assigned to only one spanning-tree instance at a time.

IST, CIST, and CST

The Internal Spanning Tree (*IST*) runs in an *MST* region. Within each *MST* region *MSTP* maintains multiple spanning tree instances. Instance 0 is known as *IST*. All other instances are numbered from 1 to 15. The *MST* is the only spanning tree instance that sends and receives *MST* configuration messages—all other instance information is encapsulated in *MST BPDU*s. Thus, in *MSTP* there are two contexts of operation, one in the context of the entire topology called *CIST* (Common Internal Spanning Tree), and the other in the context of each individual spanning tree context, i.e. *MSTI* (Multiple Spanning Tree Instance).

Operations in a MST region

All bridges in a single *MST* region have the same regional configuration. The communication among bridges inside the *MST* region is through the *IST* and the communication across bridges is taken care of by the *CIST* (Common Internal Spanning Tree) that spans across the entire topology irrespective of *MST* and *SST* regions. All bridge ports are part of all instances available in the system. Thus, when the *MSTP* protocol operates, the Port Role and Port State are calculated for the *CIST* (Common Spanning Tree Context) and separately for each instance. The operation of the protocol arrives at a single common / active topology consisting of all bridges in the topology, which is the *CIST* or the common internal spanning tree. The bridge with the best bridge identifier is chosen as the *CIST* Root. Apart from the *CIST* Root, the regions also calculate *MSTI* Regional Roots for each of the *MSTI* instances active inside the region and a *CIST* Regional root towards the *CIST* Root. The port on the *CIST* Regional Root towards the *CIST* Root is selected as a master port.

4.3. Hop Count

The Hop Count and Path Cost are used by the internal spanning tree and the multiple spanning tree to compute the spanning tree topology. IS5Com *MSTP* provides a command to configure the hop count inside the region, which is applicable to all *IST* and *MST* instances in that region. When a switch receives a *BPDU* with the hop count set to a maximum value from the root, it decrements the received remaining hop count value and propagates the new hop count value in the *BPDU* it generates. When the count reaches zero, the switch discards the *BPDU*.

4.4. Configuring MSTP Features

The following sections describe the configuration of the *MSTP* features.

Default MSTP Configuration

Apart from the default configurations mentioned in Section Default Configurations, the default configurations in *MSTP* are as follows:

Table 1: Default MSTP Configuration

Feature	Default Settings
Maximum hop count	20
Spanning-tree port cost (configurable on a per-interface basis)	200000

Configuration Guidelines

The switch supports up to 16 *MST* instances. The number of *VLAN*s that can be mapped to a particular *MST* instance is 1024.

In a spanning tree network, the switches can be in the same *MST* region only when they have the same *VLAN*-to-instance map, configuration revision number, and name.

4.5. Setting Spanning Tree Operating Mode

When the switch comes up, spanning tree is enabled by default with *MSTP* operating in the switch.

1. Execute the following commands in the switch to set the spanning tree compatibility version for STP.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree operating mode.

   ```
   iS5comm(config)# spanning-tree mode mst
   ```

   NOTE: If the user input for the spanning-tree mode is different from the specified mode of operation, then the switch shut downs the operational spanning-tree and starts the spanning-tree as per the user-input

   – Return to the Privileged EXEC mode.

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

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

   ```
   iS5comm# show spanning-tree
   Root Id         Priority   32768
   Address    00:01:02:03:04:05
   Cost       0
   Port       0 [0]
   This bridge is the root
   ```

```
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00

Spanning Tree  Protocol Enabled.
MST00 is executing the stp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
Address  00:01:02:03:04:05
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role       State        Cost     Prio   Type
----    ----       -----        ----     ----   ------
Gi0/1   Designated Forwarding   200000   128    SharedLan
```

NOTE: To make the switch compatible with *STP* use spanning-tree compatibility stp in global configuration mode, perform the following:

– Execute the no spanning-tree mode from Global Configuration mode command to set the default spanning tree operating mode.

```
iS5comm(config)#no spanning-tree mode
```

4.6. Specifying MST Mode Configuration

When the switch comes up, spanning tree is enabled by default with MSTP operating in the switch.

1. Execute the following commands in the switch to set the spanning tree compatibility version for *STP*.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Enter the *MST* Configuration submode.

   ```
   iS5comm(config)# spanning-tree mst configuration
   ```

NOTE: The *MST* configuration sub mode is used to make only instance-specific and *MST* region configurations.

– Map *VLAN*s to an *MST* instance.

```
iS5comm(config-mst)# instance 1 vlan 1
```

Instance range is 1-16 and *VLAN* range is 1-4096.

– Specify a configuration name for an *MST* region.

```
iS5comm(config-mst)# name region1
```

– Specify the configuration revision number for the mst region.

```
iS5comm(config-mst)# revision 100
```

The range is 0-200000.

– Return to the Privileged EXEC mode.

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

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

```
iS5comm# show spanning-tree mst configuration
Name        [region1]
Revision    100
Instance    Vlans mapped
--------   ------------------------------------
0          2-1024,1025-2048,2049-3072,3073-4094
1          1
-------------------------------------------------
```

4.7. Configuring Spanning Tree Switch Priority

For setup, refer to Figure Spanning Tree Topology.

1. Configure the following for creating *MST* instances and regions in all switches.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Enter the *MST* Configuration submode.

   ```
   iS5comm(config)# spanning-tree mst configuration
   ```

NOTE: The *MST* configuration sub mode is used to make only instance-specific and *MST* region configurations.

   – Map *VLAN*s to an *MST* instance.

   ```
   iS5comm(config-mst)# instance 1 vlan 1
   ```

   Instance range is 1-16 and *VLAN* range is 1-4096.

   – Specify a configuration name for an mst region.

   ```
   iS5comm(config-mst)# name region1
   ```

   – Return to the Privileged EXEC mode.

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

2. After the topology stabilizes, execute the following command in all switches to verify the multiple spanning tree information for the *CIST* (Common Internal Spanning Tree) Instance or the specified *MST* Instance. For Instance Id, the range is 1-64. Detail displays spanning tree *MST* instance specific details.

   FOR EXAMPLE: Type the following:

   – **In Switch A**

   ```
   iS5comm# show spanning-tree mst 1
   ## MST01
   ```

```
Vlans mapped:    1
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768
Root       this switch for MST01

Interface Role        Sts          Cost      Prio.Nbr  Type
--------- ----        ---          ----      --------  ---
Gi0/1     Designated  Forwarding   200000    128.1     Link Type is
Shared
Gi0/2     Designated  Forwarding   200000    128.2     Link Type is
Shared
```

– **In Switch B**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:02:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768

Interface Role        Sts          Cost      Prio.Nbr  Type
--------- ----        ---          ----      --------  ---
Gi0/1     Root        Forwarding   200000    128.1     Link Type is
Shared
Gi0/2     Designated  Forwarding   200000    128.2     Link Type is
Shared
```

– **In Switch C**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:03:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768

Interface Role        Sts          Cost      Prio.Nbr  Type
--------- ----        ---          ----      --------  ---
Gi0/1     Root        Forwarding   200000    128.1     Link Type is
Shared
Gi0/2     Designated  Forwarding   200000    128.2     Link Type is
Shared
```

3. To set the priority for *CIST* (instance 0), execute the following command:

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

```
iS5comm(config)# spanning-tree priority 4096
```

```
iS5comm(config)# end
iS5comm# show spanning-tree
Root Id Priority 4096
Address e8:e8:75:80:01:e9
Cost 0 Port 0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol has been enabled
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id Priority 4096
Address e8:e8:75:80:01:e9
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name  Role       State      Cost    Prio Type
----  ----       -----      ----    ---- ------
Gi0/2 Designated Forwarding 200000  128  P2P
```

4. Execute the following commands in Switch B.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode in ISS1.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree priority.

   ```
   iS5comm(config)# spanning-tree mst 1 priority 4096
   ```

   For instance id, the range is 1 to 64.

   For priority, the range is 0 to 61440 in increments of 4096; the default is 32768. The lower the number, the more likely the switch will be chosen as the Root Switch. Valid priority values are multiples of 4096.

NOTE: spanning-tree priority “xxx” configures the priority in *RSTP* if *RSTP* is running, or it configures the *CIST* priority if *MSTP* is running. Spanning-tree mst instance priority configures the priority in *MSTI*, and it is supported only if *MSTP* is running.

NOTE: Observation after configuring the switch Priority for Switch B

Switch A becomes the designated bridge with port 1 as a Root Port and port 2 as a designated port.

– Return to the Privileged EXEC mode.

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

5. After the topology stabilizes, execute the following command in all switches.

   FOR EXAMPLE: Type the following:

– **In Switch A**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 4096

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Root        Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
```

– **In Switch B**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:02:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 32768
Root       this switch for MST01

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Designated  Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
```

– **In Switch C**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:03:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 4096

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Alternate   Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Root        Forwarding  200000   128.2     Link Type is Shared
```

6. Execute the no spanning-tree priority from the Global Configuration mode command to set the Priority to its default value.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm(config)#no spanning-tree priority
   ```

4.8. Configuring MST Properties of an Interface

For setup, refer to Figure Spanning Tree Topology for Configuring Port Priority.

1. Configure the following for creating *MST* instances and regions in all switches.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the *MST* Configuration submode.

   ```
   iS5comm(config)# spanning-tree mst configuration
   ```

NOTE: The *MST* configuration sub mode is used to make only instance-specific and *MST* region configurations.

   – Map *VLAN*s to an *MST* instance.

   ```
   iS5comm(config-mst)# instance 1 vlan 1
   ```

   Instance range is 1-16 and *VLAN* range is 1-4096.

   – Specify a configuration name for an mst region.

   ```
   iS5comm(config-mst)# name region1
   ```

   – Return to the Privileged EXEC mode.

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

2. After the topology stabilizes, execute the following command in all switches.

   FOR EXAMPLE: Type the following:

   – **In Switch A**

   ```
   iS5comm# show spanning-tree mst 1
   ## MST01
   Vlans mapped:    1
   Bridge     Address 00:01:02:03:04:01    Priority 32768
   Root       Address 00:01:02:03:04:01    Priority 32768
   Root       this switch for MST01

   Interface Role        Sts         Cost     Prio.Nbr  Type
   --------- ----        ---         ----     --------  ---
   Gi0/1     Designated  Forwarding  200000   128.1     Link Type is Shared
   Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
   Gi0/3     Designated  Forwarding  200000   128.2     Link Type is Shared
   ```

   – **In Switch B**

   ```
   iS5comm# show spanning-tree mst 1
   ## MST01
   Vlans mapped:    1
   Bridge     Address 00:02:02:03:04:01    Priority 32768
   Root       Address 00:01:02:03:04:01    Priority 32768
   ```

```
Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Root        Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
```

– **In Switch C**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:03:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Root        Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Alternate   Forwarding  200000   128.2     Link Type is Shared
Gi0/3     Alternate   Forwarding  200000   128.3     Link Type is Shared
```

3. Execute the following commands in Switch A.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Specify the interface for which the port priority is to be configured.

   ```
   iS5comm(config)# interface gigabitethernet 0/3
   ```

   – Configure the port priority for spanning tree.

   ```
   iS5comm(config-if) # spanning-tree mst 1 port-priority 32
   ```

   For priority, the range is 0 to 240 in increments of 16. The default is 128. The lower the number, the higher the priority.

   Valid priority values are 0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, and 240. All other values are rejected.

   Valid MST instance must exist prior to the execution of this command.

   NOTE: Observation after configuring the port Priority for Port 3 in Switch A: Port 1 and Port 2 of Switch B are Alternate Ports and Port 3 is the root port.

   – Return to the Privileged EXEC mode.

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

4. View the multiple spanning tree information for the *CIST* (Common Internal Spanning Tree) Instance or specified *MST* Instance by executing the following command in all switches. For “instance id”, the range is 1-64; detail displays spanning tree *MST* instance specific details.

   FOR EXAMPLE: Type the following:

   – **In Switch A**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 4096

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Designated  Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
Gi0/3     Designated  Forwarding  200000   32.3      Link Type is Shared
```

– **In Switch B**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:02:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 32768

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Root        Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Designated  Forwarding  200000   128.2     Link Type is Shared
```

– **In Switch C**

```
iS5comm# show spanning-tree mst 1
## MST01
Vlans mapped:    1
Bridge     Address 00:03:02:03:04:01    Priority 32768
Root       Address 00:02:02:03:04:01    Priority 32768

Interface Role        Sts         Cost     Prio.Nbr  Type
--------- ----        ---         ----     --------  ---
Gi0/1     Alternate   Forwarding  200000   128.1     Link Type is Shared
Gi0/2     Root        Forwarding  200000   128.2     Link Type is Shared
```

5. Execute the no spanning-tree mst instance id port-priority Interface Configuration mode command for the default settings.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm(config)#no spanning-tree mst 1 priority
   ```

4.9. Configuring MST Hello-Time

Hello-Time must be configured if it is required to configure the interval between the configuration messages generated by the Root Switch.

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 Hello-Time is to be changed.

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

   – Configure the *MST* Hello-Time.

   ```
   S5comm(config-if) # spanning-tree mst hello-time 1
   ```

   NOTE: For seconds, the range is 1 to 2; the default is 2

   – Return to the Privileged EXEC mode.

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

   – View *MST* port specific configuration.

   ```
   iS5comm# show spanning-tree mst interface gigabitethernet 0/1
   Gi0/1 of MST00 is Designated, Forwarding
   Edge port: no
   Link type: Shared
   Port Hello Timer: 1 Sec 0 cs
   Bpdus sent 271 , Received 308
   Instance  Role         Sts          Cost     Prio.Nbr
   --------  ----         ---          ----     --------
   0         Designated   Forwarding   200000   128.1
   1         Designated   Forwarding   200000   128.1
   ```

   – Execute the *no spanning-tree mst hello-time*Interface Configuration mode command to set the default value for the hello-time.

   ```
   iS5comm(config-if) # no spanning-tree mst hello-time
   ```

4.10. Configuring Maximum Hop Count

The maximum hop count is the maximum number of hops a packet can traverse before getting discarded and the information held for a port is aged out.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure the maximum hop count.

```
iS5comm(config) # spanning-tree mst max-hops 10
```

The max-hop value ranges from 6-40. The default value is 20.

– Return to the Privileged EXEC mode.

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

– View *MST* port specific configuration.

```
iS5comm# show spanning-tree mst detail
## MST00
Bridge     Address 00:04:02:03:04:01    Priority 32768
Root       Address 00:04:02:03:04:01    Priority 32768
 We are the Root for CST
 Port 0         ,  path cost 0
IST Root   Address 00:04:02:03:04:01    Priority 32768
 Path cost 0
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 10
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Gi0/1 of MST00 is Designated, Forwarding
Port info      port id 128.1  priority 128 cost 200000
Designated root   address 00:04:02:03:04:01    priority 32768 cost 0
Designated ist master address 00:04:02:03:04:01   priority 32768 cost 0
Designated bridge    address 00:04:02:03:04:01   priority 32768 portid
128.1
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 10
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Bpdus sent 36 , Received 0
```

– Execute the no spanning-tree mst max-hops Global Configuration mode command to configure the max hop count to its default value.

```
iS5comm(config-if) # no spanning-tree mst max-hops
```

Configurations Common for both RSTP and MSTP

5. Configuring RSTP and MSTP

The following sections describe the configuration which is common for both the *RSTP* and *MSTP*.

5.1. Configuring Transmit Hold Count

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

CONTEXT:

The number or *BPDU*s that can be transmitted during every Hello Time period ranges from a minimum of one and 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.

   ```
   iS5comm(config)# spanning-tree transmit hold-count 9
   ```

   The transmit hold count ranges from 1-10. The default value is 3.

   – Return to the Privileged EXEC mode.

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

   – View the spanning tree details..

   ```
   iS5comm# show spanning-tree detail
   Spanning tree Protocol Enabled.
   MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
   Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
   Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
   Configured Hello Time 2 sec 0 cs
   We are root of the spanning tree
   Current Root has priority 32768, address  00:01:02:03:04:01
   cost of root path is 0
   Number of Topology Changes 1, Time since topology Change 100 seconds ago
   ```

```
Transmit Hold-Count 9
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
```

– Execute the no spanning-tree transmit hold-count Global Configuration mode command to configure the transmit hold-count to its default value.

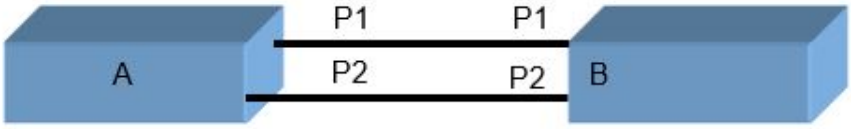
```
iS5comm(config-if) # no spanning-tree transmit hold-count
```

5.2. Configuring Dynamic Path Cost

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

CONTEXT:

Figure 1: Topology for Configuring Dynamic Path Cost



For topology, refer to the figure above. The path cost of all ports can be calculated dynamically based on the speed of the interface. By default, dynamic path cost calculation is disabled.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – View the output before configuring the dynamic path cost in Switch A.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
 Address    00:01:02:03:04:01
 Cost       0
Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id     Priority  32768
Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1  Designated    Forwarding   20000    128    SharedLan
Gi0/2  Designated    Forwarding   20000    128    SharedLan
```

– View the output before configuring the dynamic path cost in Switch A.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
 Port       1 [Gi0/1]
 Max age 20 sec 0 cs, forward delay  15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id    Priority  32768
Address  00:02:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Root         Forwarding   20000    128    SharedLan
Gi0/2   Alternate    Discarding   20000    128    SharedLan
```

To configure the dynamic path cost:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Configure the dynamic path cost.

```
iS5comm(config)# spanning-tree pathcost dynamic
```

– Reduce the speed of gigabit Ethernet 0/1 to 10 Mbps..

```
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no negotiation
iS5comm(config-if)#speed 10
```

– Return to the Privileged EXEC mode.

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

– View the spanning tree details in Switch B.

```
iS5comm# show spanning-tre
 Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
Port       2 [Gi0/2]
              Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
```

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:02:02:03:04:01
          Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ----
Gi0/1   Alternate    Discarding   2000000  128    P2P
Gi0/2   Root         Forwarding   20000    128    P2P
```

NOTE: If the path cost is already configured for a *CIST* or an *RSTP* interface this command has no effect on such ports.

If the cost has been configured previously for an *MST* instance on a particular interface, this command has no effect on that instance in the specified interface. Whereas the path cost of all other instances on the same interface will be calculated dynamically.

5.3. Configuring Dynamic Path Cost in Aggregate Port

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

CONTEXT:

The path cost of a port channel is the path cost corresponding to the aggregated speed of all member ports of the port channel.

The path cost of a port channel will be determined when there is an operational status change for the port channel. There will not be any path cost recalculation for the port channel if there is operational status change for any of the individual member ports.

For setup, refer to Figure Topology for Configuring Dynamic Path Cost. P1 and P2 are aggregated into a port channel interface.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – View the default output in Switch B.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
 Port       1 [Gi0/1]
 Max age 20 sec 0 cs, forward delay  15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
```

```
Bridge Id    Priority  32768
Address  00:02:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Root         Forwarding   20000    128    SharedLan
Gi0/2   Alternate    Discarding   20000    128    SharedLan
```

Configuration of Path Cost

Configure the Path Cost as dynamic in both the switches

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Configure the dynamic path cost.

```
iS5comm(config)# spanning-tree pathcost dynamic
```

– Create and enable port channel in both the switches.

```
iS5comm(config)# set port-channel enable
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# channel-group 1 mode active
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config-if)# channel-group 1 mode active
```

– Return to the Privileged EXEC mode.

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

– View the output in Switch B using the following command.

```
iS5comm# show spanning-tre
 Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost 99900
Port 25 [po1]
              Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:02:02:03:04:01
```

```
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Root         Forwarding   99900    128    P2P
```

NOTE: If the path cost is already configured for a CIST or an RSTP interface this command has no effect on such ports.

If the cost has been configured previously for an *MST* instance on a particular interface, this command has no effect on that instance in the specified interface. Whereas the path cost of all other instances on the same interface will be calculated dynamically.

2. Disconnect the cable connecting Port 2 of both the switches.
3. View the output in Switch B.

   FOR EXAMPLE: Type the following:

   – View the default output in Switch B.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0                Port       0 [0]
 This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Designated   Forwarding   99900    128    P2P
```

NOTE: Even after the cable is removed, the path cost is not changed. The path cost will be re-calculated only when there is an operational status change of the Port channel interface, and not when operational status of a port in a bundle changes.

NOTE: A value of 100 is subtracted from Pathcost calculated for Port channel. This is done to give more preference to Port channel over physical port.

NOTE: Above mentioned behavior is seen when path cost re-calculation on port speed change is disabled. Please refer to section 3.3.4 for further details on enabling path cost re-calculation on port speed change.

4. In Switch B, make the administrative status of port channel interface down and then up.

   FOR EXAMPLE: Type the following:

```
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# shutdown
iS5comm(config-if)# no shutdown
iS5comm(config-if)# end
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0                Port       0 [0]
 This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Designated   Forwarding   199900   128    P2P
```

   NOTE: The path cost will be recalculated when there is an administrative status change

   Execute the no spanning-tree pathcost dynamic Global Configuration command to disable dynamic pathcost calculation

```
iS5comm(config)# no spanning-tree pathcost dynamic
```

5.4. Enabling Path Cost Re-calculation on Port Speed Change

CONTEXT:

The path cost of a port channel is the path cost corresponding to the aggregated speed of all member ports of the port channel.

The path cost of a port channel will be recalculated whenever a port becomes Active/In-Active in the channel group.

For setup, refer to Figure Topology for Configuring Dynamic Path Cost. P1 and P2 are aggregated into a port channel interface.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – View the output before configuring the dynamic path cost on speed change in Switch A.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       0
 Port      0 [0]
This bridge is the root
 Max age 20 sec 0 cs, forward delay  15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id    Priority  32768
Address  00:02:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Designated   Forwarding   20000    128    SharedLan
Gi0/2   Designated   Discarding   20000    128    SharedLan
```

Output before configuring the dynamic path cost on speed change in Switch B

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
 Port       1 [Gi0/1]
 Max age 20 sec 0 cs, forward delay  15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id    Priority  32768
Address  00:02:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
```

```
----    ----         -----        ----     ----   ------
Gi0/1   Root         Forwarding   20000    128    SharedLan
Gi0/2   Alternate    Discarding   20000    128    SharedLan
```

2. **Configuration of dynamic cost calculation for Lagg**

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

   – Configure the dynamic path cost lag-speed.

```
iS5comm(config)# spanning-tree pathcost dynamic lag-speed
```

   – Create and enable port channel in both the switches.

```
iS5comm(config)# set port-channel enable
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# channel-group 1 mode on
iS5comm(config-if)# exit
```

   – Return to the Privileged EXEC mode.

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

   – View the output in Switch B using the following command.

```
iS5comm# show spanning-tre
 Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost 99900
Port 25 [po1]
              Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:02:02:03:04:01
           Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Root         Forwarding   200000   128    P2P
```

3. Make Port 2 as member of Port Channel on both switches.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config-if)# channel-group 1 mode on
iS5comm(config-if)# exit
```

4. View the output in Switch B.

   FOR EXAMPLE: Type the following:

   – View the default output in Switch B.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost 100000
                Port 25 [po1]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Designated   Forwarding   100000   128    P2P
```

5. Remove Port 2 from Port Channel on both the switches.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config-if)# no channel-group
iS5comm(config-if)# exit
```

6. View the output in Switch B.

   FOR EXAMPLE: Type the following:

   – View the default output in Switch B.

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost 100000
```

```
                Port 25 [po1]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
 Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/2   Alternate    Discarding   20000    128    SharedLan
po1     Designated   Forwarding   20000    128    P2P
```

7. Execute the no spanning-tree pathcost dynamic lag-speed Global Configuration command to disable dynamic pathcost calculation on aggregated port speed change.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm(config)# no spanning-tree pathcost dynamic lag-speed
   ```

   NOTE: On disabling dynamic pathcost calculation on speed change the calculated pathcost value for Port channel will not be re-calculated. There after the value will be recalculated for the port channel as the Dynamic Path Cost calculation is explained in Section “Configuring Dynamic Path cost in Aggregate Port”

5.5. Configuring Auto Edge

CONTEXT:

The Auto Edge feature is used to enable automatic detection of edge devices or bridges connected to an interface.

For setup, refer to Figure Topology for Configuring Dynamic Path Cost.

1. Configure the path cost as dynamic in both the switches.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   iS5comm(config-if)# spanning-tree auto-edge
   iS5comm(config-if)# end
   ```

   NOTE: The following output is displayed if Port 1 is connected to a host.

   – View the spanning tree details.

```
iS5comm# show spanning-tree detail
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 100 seconds ago
Transmit Hold-Count 9
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  2000000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 0,Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:05
Designated Bridge has priority 32768, address 00:01:02:03:04:05
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State: 6
PortFast is enabled
Link type is point to Point
BPDUs : sent 112, received 994
Restricted Role is disabled.
Restricted TCN is disabled.
```

NOTE: The following output is displayed if Port 1 is connected to a host.

– View the spanning tree details.

```
iS5comm# show spanning-tree detail
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 100 seconds ago
Transmit Hold-Count 9
```

```
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  2000000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 0,Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:05
Designated Bridge has priority 32768, address 00:01:02:03:04:05
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State: 7
PortFast is enabled
Link type is point to Point
BPDUs : sent 112, received 994
Restricted Role is disabled.
Restricted TCN is disabled.
```

– Execute the no spanning-tree auto-edge Interface Configuration Mode command to disable automatic detection of bridge/edge devices.

```
iS5comm(config-if) # no spanning-tree auto-edge
```

5.6. Configuring restricted-role

CONTEXT:

When a port is configured with restricted-role, the port cannot be root port. The spanning tree information received on the configured port is subjected to role selection. If the received information is superior, then the port will be selected as alternate port or backup port. If the received information is inferior, then the port will be selected as designated port. By default, the restricted-role feature is disabled. In case of provider bridges, restricted role is enabled for all customer network ports.

1. Execute the following show command to view the restricted-role status.

   FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree detail
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 100 seconds ago
```

```
Transmit Hold-Count 9
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  2000000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 0,Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:05
Designated Bridge has priority 32768, address 00:01:02:03:04:05
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State: 6
PortFast is enabled
Link type is point to Point
BPDUs : sent 112, received 994
Restricted Role is disabled.
Restricted TCN is disabled.
```

2. Execute the following commands to configure the root-guard / restricted role feature on the port in both the switches.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

```
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree restricted-role
iS5comm(config-if)# end
```

   – View the restricted role configuration using the following command.

```
iS5comm# show spanning-tree detail
Spanning tree Protocol Enabled.
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 100 seconds ago
Transmit Hold-Count 9
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  2000000, Port priority  128,
```

```
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 0,Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:05
Designated Bridge has priority 32768, address 00:01:02:03:04:05
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State: 6
PortFast is enabled
Link type is point to Point
BPDUs : sent 112, received 994
Restricted Role is enabled.
Restricted TCN is disabled.
```

– Execute the no spanning-tree restricted-role Interface Configuration mode command to disable the root-guard / restricted role feature on the port.

```
iS5comm(config-if) # no spanning-tree restricted-role
```

5.7. Configuring Restricted TCN

CONTEXT:

For setup, refer to Figure Spanning Tree Topology.

When a port is configured as Restricted *TCN*, the port will not process and propagate any topology change information received on the configured port. Enabling this configuration might result in temporary connectivity loss after changes in active spanning tree topology because of incorrect learnt station location information.

By default, the restricted-tcn feature is disabled.

In case of Provider Bridges, Restricted *TCN* will always be enabled on Customer Network Ports.

1. Execute the following commands to configure the Restricted *TCN* feature on the port.

   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 restricted *TCN* feature.

   ```
   iS5comm(config-if)# spanning-tree restricted-tcn
   ```

   – Return to the Privileged EXEC mode.

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

   – View the spanning tree details.

   ```
   iS5comm# show spanning-tree detail
   Spanning tree Protocol Enabled.
   ```

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 200000
Number of Topology Changes 11, Time since topology Change 100 seconds
ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Alternate     , Discarding
Gi0/1 is operating in the MSTP Mode
Port path cost  2000000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 7
PortFast is disabled
Link type is point to Point
BPDUs : sent 171, received 1000
Restricted Role is disabled.
Restricted TCN is enabled.
```

– Execute the no spanning-tree restricted-tcn Interface Configuration mode command to disable the topology change guard/ restricted *TCN* feature on the port..

```
iS5comm(config-if) # no spanning-tree restricted-tcn
```

5.8. Restarting Protocol Migration Process

CONTEXT:

IS5Com *MSTP* can detect the version of spanning tree being used on a LAN and send out equivalent type of *BPDU*. If this switch receives a legacy IEEE 802.1D configuration *BPDU* (a *BPDU* with the protocol version set to 0), it sends only IEEE 802.1D *BPDU* on that port.

IS5Com *MSTP* supports force version feature where a switch supporting *MSTP* is made to behave as *STP* or *RSTP*. However, the switch does not automatically revert to the *MSTP* mode if it does not receive IEEE 802.1D *BPDU*s, because it cannot determine whether the legacy switch has been removed from the link unless the legacy switch is the designated switch.

To restart the protocol migration process (force the renegotiation with neighboring switches) on the switch, use the clear spanning-tree detected-protocols command.

To restart the migration process on a specific interface, use clear spanning-tree detected-protocols interface interface-id command (see below).

```
iS5comm# clear spanning-tree detected protocols interface gigabitethernet
0/12
```

5.9. Configuring Spanning Tree BPDU receive status

CONTEXT:

If bpdu-transmit status on a port is configured as disabled, no *BPDU*s will be transmitted through this port. For setup, refer to Figure Spanning Tree Topology.

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 *BPDU* transmit status configuration is to be done.

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

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

   – Configure the *BPDU* receive status.

   ```
   iS5comm(config-if)# spanning-tree bpdu-receive disabled
   ```

   – Return to the Privileged EXEC mode.

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

5.10. Configuring Spanning Tree BPDU transmit status

CONTEXT:

If bpdu-transmit status on a port is configured as disabled, no *BPDU*s will be transmitted through this port. For setup, refer to Figure Spanning Tree Topology.

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 *BPDU* transmit status configuration is to be done.

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

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

– Configure the *BPDU* transmit status.

```
iS5comm(config-if)# spanning-tree bpdu-transmit disabled
```

– Return to the Privileged EXEC mode.

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

5.11. Displaying Spanning Port Information

CONTEXT:

The following command displays the port information.

1. Execute the following show command to view the restricted-role status.

   FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id10is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 2
PortFast is disabled
Link Type is Shared
BPDUs : sent 6, received 0
Restricted Role is disabled.
Restricted TCN is disabled.
Gi0/1 is operating as Layer Two Gateway Port
MST00 PseudoRootId Priority 4096, MacAddress 00:01:02:03:04:01
bpdu-transmit disabled
bpdu-receive enabled
```

Displaying MST Configuration and Status

1. The following commands display the status and configuration details of *MST*.

   FOR EXAMPLE: Type the following:

   – View the restricted role configuration using the following command.

```
iS5comm# show spanning-tree mst configuration
Name            [00:04:02:03:04:01]
Revision        0
```

```
Instance        Vlans mapped
--------      ----------------------------------------
  0              1-1024,1025-2048,2049-3072,3073-4094
-------------------------------------------------------
```

– The following output is displayed when an instance is not created on a Port.

```
iS5comm# show spanning-tree mst detail
 ## MST00
Bridge     Address 00:04:02:03:04:01    Priority 32768
Root       Address 00:04:02:03:04:01    Priority 32768
           We are the Root for CST
           Port 0        ,  path cost 0
IST Root   Address 00:04:02:03:04:01    Priority  32768
           Path cost 0
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 20
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Gi0/1 of MST00 is Designated, Forwarding
Port info             port id 128.1             priority 128 cost 200000
Designated root       address 00:04:02:03:04:01   priority 32768 cost 0
Designated ist master address 00:04:02:03:04:01   priority 32768 cost 0
Designated bridge     address 00:04:02:03:04:01   priority 32768 portid
128.1
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 20
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Bpdus sent 36 , Received 0
```

– The following output is displayed when instance 1 is mapped to VLAN 1.

```
iS5comm# show spanning-tree mst detail
 ## MST00
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768
           We are the Root for CST
           Port 0        ,  path cost 0
IST Root   Address 00:01:02:03:04:01    Priority  32768           Path
cost 0
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 20
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Gi0/1 of MST00 is Designated, Forwarding
Port info             port id 128.1               priority 128   cost
200000
Designated root       address 00:01:02:03:04:01   priority 32768 cost 0
Designated ist master address 00:01:02:03:04:01   priority 32768 cost 0
```

```
Designated bridge     address 00:01:02:03:04:01   priority 32768 portid
128.1
Configured Forward delay 15 sec 0 cs, Max age 20 sec 0 cs, Max hops 20
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Bpdus sent 127 , Received 0

 ## MST01
Vlans mapped:    1
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768
Root       this switch for MST01

Gi0/1 of MST01 is Designated, Forwarding
Port info         port id 128.1               priority 128   cost 200000
Designated root   address 00:01:02:03:04:01   priority 32768 cost 0
Designated bridge address 00:01:02:03:04:01   priority 32768 port id
128.1
iS5comm# show spanning-tree mst 1
## MST00
Vlans mapped:    1
Bridge     Address 00:01:02:03:04:01    Priority 32768
Root       Address 00:01:02:03:04:01    Priority 32768
Root       this switch for MST01
Interface Role        Sts          Cost     Prio.Nbr Type
--------- ----        ---          ----     -------- ----
Gi0/1     Designated  Discarding   200000   128.1    Link Type is Shared
Gi0/2     Designated  Discarding   200000   128.2    Link Type is Shared
iS5comm# show spanning-tree mst interface gigabitethernet 0/1
Gi0/1 of MST00 is Designated, Forwarding
Edge port: no
Link type: Shared
Port Hello Timer: 2 Sec 0 cs
Bpdus sent 233 , Received 270
Instance  Role         Sts          Cost     Prio.Nbr
--------  ----         ---          ----     --------
0         Designated   Forwarding   200000   128.1
1         Designated   Forwarding   200000   128.1
```

Configuring Spanning Tree in Provider Bridges

6. Configuring Spanning Tree in Provider Bridges

Based on services offered to the customer, Provider Bridges are two types: Provider Edge Bridge and Provider Core Bridge.

- **Provider Edge Bridge**—it consists of a *C-VLAN* (Customer *VLAN*) component and a *S-VLAN* (Service VLAN) component where each component is viewed as a separate bridge. The *S-VLAN* component consists of ports other than Customer Edge Ports and Provider Edge ports. The *C-VLAN* component consists of Customer Edge Port and Provider Edge Port (Logical Port) bridge ports. Each Customer Edge Port consists of one *C-VLAN* component. In a Provider Edge Bridge, there can be multiple *C-VLAN* components and one *S-VLAN* component

  A spanning tree instance (RSTP/ MSTP) runs in an S-VLAN component, and it is called an S-VLAN Spanning Tree or Provider Bridge Spanning tree. This spanning tree treats S-VLAN component as a separate bridge and it calculates the port state only for the port that belongs to the S-VLAN component.

  On each C-VLAN component, there is a separate instance of Rapid Spanning Tree (RSTP), which is named a Customer Spanning Tree or a C-VLAN Spanning Tree. For this spanning tree, the bridge ports are the Customer Edge Port and the Provider Edge ports in the corresponding component.

- **Provider Core Bridge**—it consists of only one *S-VLAN* component.

For more information on Provider Edge Bridge, Provider Core Bridge, and their port types, refer to iS5Com VLAN Config User manual.

6.1. Configuring Global Spanning Tree Module Status

CONTEXT:

This configuration enables or disables all *C-VLAN* spanning trees and *S-VLAN* spanning trees. By default, the Global Spanning Tree module status is always enabled.

1. Configure port 1 as *CEP* (Customer Edge Port).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# configure terminal
   iS5comm(config)# spanning-tree
   iS5comm# show spanning-tree
   ```

```
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
                Port       0 [0]
                This bridge is the root
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
S-VLAN Component: MST00 is executing the mstp compatible Multiple
Spanning Tree Protocol
Bridge Id     Priority  32768
              Address  00:01:02:03:04:01
              Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
              Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Disabled     Discarding   200000   128   SharedLan
Gi0/2   Designated   Forwarding   200000   128   SharedLan
Gi0/3   Designated   Forwarding   200000   128   SharedLan
Gi0/4   Designated   Forwarding   200000   128   SharedLan
Gi0/5   Designated   Forwarding   200000   128   SharedLan
Gi0/6   Designated   Forwarding   200000   128   SharedLan
Gi0/7   Designated   Forwarding   200000   128   SharedLan

iS5comm# show customer spanning-tree cep interface gigabitethernet 0/1
Port [Gi0/1]
We are the root of the Spanning Tree
Root Id         Priority   65535
                Address    00:01:02:03:04:01
                Cost       0
                Root Ports
               Hello Time 2 Sec 0 cs, Max Age 0 Sec 0 cs, Forward Delay
0 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id       Priority 65535
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec  0 cs, Forward
Delay 0 sec 0 cs
Name      Role        State        Cost     Prio   Type
```

```
----      ----        -----        ----     ----   ------
CEP-Gi0/1 Designated  Discarding   200000   32     SharedLan

iS5comm# configure terminal
iS5comm(config)# no spanning-tree
iS5comm# show spanning-tree
Root Id         Priority   0
                Address    00:00:00:00:00:00
                Cost       0
            Port     0 [0]            This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol has been disabled
Provider Spanning tree Protocol enabled
Bridge Id       Priority  32768
                Address  00:00:00:00:00:00
           Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Disabled     Unknown      200000   128    SharedLan
Gi0/2   Disabled     Unknown      200000   128    SharedLan
Gi0/3   Disabled     Unknown      200000   128    SharedLan
Gi0/4   Disabled     Unknown      200000   128    SharedLan
Gi0/5   Disabled     Unknown      200000   128    SharedLan
Gi0/6   Disabled     Unknown      200000   128    SharedLan
Gi0/7   Disabled     Unknown      200000   128    SharedLan

iS5comm# show customer spanning-tree cep interface gigabitethernet 0/1
Port [Gi0/1] Root Id         Priority   0
                Address    00:00:00:00:00:00
                Cost       0
                Root Ports
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id       Priority 65535
                Address 00:01:02:03:04:01
```

```
                Hello Time 2 sec 0 cs, Max Age 0 sec 0 cs,
Forward Delay 15 sec 0 cs
Name      Role        State        Cost     Prio   Type
----      ----        -----        ----     ----   ------
CEP-Gi0/1 Disabled    Unknown      200000   32     SharedLan
```

6.2. Configuring Provider Spanning Tree Module Status

CONTEXT:

This configuration enables the spanning-tree provider operation. The Provider Spanning Tree can be enabled or disabled independently of the Customer Spanning Tree. The Provider Spanning Tree Module status will not affect the *C-VLAN* spanning tree.

1. Configure Provider Spanning Tree.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree provider
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
                Port       0 [0]
                This bridge is the root
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
S-VLAN Component: MST00 is executing the mstp compatible Multiple
Spanning Tree Protocol
Bridge Id     Priority  32768
              Address  00:01:02:03:04:01
              Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
              Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Disabled     Discarding   200000   128    SharedLan
Gi0/2   Designated   Forwarding   200000   128    SharedLan
Gi0/3   Designated   Forwarding   200000   128    SharedLan
Gi0/4   Designated   Forwarding   200000   128    SharedLan
Gi0/5   Designated   Forwarding   200000   128    SharedLan
Gi0/6   Designated   Forwarding   200000   128    SharedLan
```

```
Gi0/7   Designated   Forwarding   200000   128    SharedLan
```

NOTE: The *S-VLAN* Component Spanning Tree runs *MSTP* by default.

```
iS5comm# configure terminal
iS5comm(config)# no spanning-tree provider
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:00:00:00:00:00
Cost       0
Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
Provider Spanning tree Protocol has been disabled
Bridge Id    Priority  32768
Address  00:00:00:00:00:00
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Disabled     Unknown      200000   128    SharedLan
Gi0/2   Disabled     Unknown      200000   128    SharedLan
Gi0/3   Disabled     Unknown      200000   128    SharedLan
Gi0/4   Disabled     Unknown      200000   128    SharedLan
Gi0/5   Disabled     Unknown      200000   128    SharedLan
Gi0/6   Disabled     Unknown      200000   128    SharedLan
Gi0/7   Disabled     Unknown      200000   128    SharedLan
```

6.3. Configuring Customer Spanning Tree Module Status

CONTEXT:

There is no other configuration provided for the *C-VLAN* spanning tree except the setting of the module status. The *C-VLAN* Spanning tree is disabled when Spanning tree is disabled on the Customer Edge Port.

Similarly, the *C-VLAN* Spanning tree is enabled when the Spanning tree is enabled on the Customer Edge Port. By default, the Spanning tree is enabled on all ports.

1. Configure Customer Spanning Tree.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no spanning-tree disable
iS5comm(config-if)# end
iS5comm# show customer spanning-tree cep interface gigabitethernet 0/1
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
Root Ports
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id       Priority 65535
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs,
                Forward Delay 15 sec 0 cs
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
CEP-Gi0/1 Designated   Discarding   200000   32     SharedLan


iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree disable
iS5comm(config-if)# end
iS5comm# show customer spanning-tree cep interface gigabitethernet 0/1
Root Id         Priority   0
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
Root Ports
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id       Priority 65535
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs,
```

```
                Forward Delay 15 sec 0 cs
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
CEP-Gi0/1 Disabled     Unknown      200000   32     SharedLan
```

Flow Based Configurations

7. Flow Based Configurations

The following sections describe the Flow Based configurations.

7.1. Configuring Provider Spanning Tree Module Status

Configuration Guidelines

CONTEXT:

The guidelines for achieving topology convergence using Rapid Spanning Tree Protocol (*RSTP*) are as follows.

A bridge with lowest bridge priority in the topology becomes the root bridge.

Default Configurations

CONTEXT:

For STP Default Configurations, refer to section 3.7 Default Configurations.

Configuration Steps

CONTEXT:

Refer to Figure Spanning Tree Topology for the topology setup.

By default, all switches will run Multiple Spanning Tree Protocol

1. Execute the following commands to change the Spanning Tree Protocol mode to *RSTP*.

   FOR EXAMPLE: Type the following:

   At Switch A:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Configure the Spanning Tree Mode as “rstp”

   ```
   iS5comm(config)# spanning-tree mode rstp
   ```

   – Exit from the Global Configuration Mode

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

At Switch B:

– Enter the Global Configuration Mode

```
iS5comm# configure terminal
```

– Configure the Spanning Tree Mode as “rstp”

```
iS5comm(config)# spanning-tree mode rstp
```

– Exit from the Global Configuration Mode

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

At Switch C:

– Enter the Global Configuration Mode

```
iS5comm# configure terminal
```

– Configure the Spanning Tree Mode as “rstp”

```
iS5comm(config)# spanning-tree mode rstp
```

– Exit from the Global Configuration Mode

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

NOTE: Now Switch C will be the root of the spanning tree as its bridge priority is lesser than all other bridges on the spanning tree.

2. Execute the following command to view the Spanning Tree port roles and port states after 22 seconds

FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree
```

The Output in Switch A, B, C is as follows.

Switch A:

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:03:02:03:04:01
Cost       200000
Port       Gi0/2
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol

Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name  Role         State        Cost     Prio   Type
----  ----         -----        ----     ----   ------
Gi0/1 Designated   Forwarding   200000   128    SharedLan
Gi0/2 Root         Forwarding   200000   128    SharedLan
```

Switch B:

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:03:02:03:04:01
Cost       200000
Port       Gi0/2
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol

Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name  Role         State        Cost     Prio   Type
----  ----         -----        ----     ----   ------
Gi0/1 Alternate    Discarding   200000   128    SharedLan
Gi0/2 Root         Forwarding   200000   128    SharedLan
```

Switch C:

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:03:02:03:04:01
Cost       0
Port       0
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol

Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name  Role         State        Cost     Prio   Type
----  ----         -----        ----     ----   ------
Gi0/1 Designated   Forwarding   200000   128    SharedLan
Gi0/2 Designated   Forwarding   200000   128    SharedLan
```

3. Configure the port path cost for Port P2 on switch B as 4094.

   FOR EXAMPLE: Type the following:

   At Switch B:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Exit from the Interface Configuration Mode.

```
iS5comm(config)# interface gigabitethernet 0/2
```

– Configure the port path cost for port 2 as 4094.

```
iS5comm(config-if)# spanning-tree cost 4094
```

– Exit from the Interface Configuration Mode.

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

NOTE: Now Port P1 of the switch B goes to designated and Port P1 of switch A goes to Alternate.

4. View the spanning tree port roles and port states after 22 seconds using the following command.

FOR EXAMPLE: Type the following:

The Output in Switch A, B, C is as follows.

Switch A

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:03:02:03:04:01
Cost       200000              Port       Gi0/2Max Age 20 sec 0 cs,
Forward Delay 15 sec 0 cs

Bridge is executing the rstp compatible Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs

Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ----
Gi0/1  Alternate   Discarding   200000   128    SharedLan
Gi0/2  Root        Forwarding   200000   128    SharedLan
```

Switch B

```
iS5comm# show spanning-tree
Root Id         Priority   0
                Address    00:03:02:03:04:01
                Cost 4094               Port       Gi0/2
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
```

```
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs


Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ----
Gi0/1  Designated  Forwarding   200000   128    SharedLan
Gi0/2  Root        Forwarding   4094     128    SharedLan
```

Switch C

```
iS5comm# show spanning-tree
Root Id         Priority   0
                Address    00:03:02:03:04:01
                Cost 0               Port 0               Max Age 20
sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs

Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ----
Gi0/1  Designated  Forwarding   200000   128    SharedLan
Gi0/2  Designated  Forwarding   200000   128    SharedLan
```

7.2. Topology Convergence in Case of MSTP

Configuration Guidelines

CONTEXT:

The guidelines for the configuration of multiple spanning tree protocol are as follows:

- Create Multiple *VLAN*s with member ports on all switches
- Create Multiple Instances of Spanning tree on all switches.
- Assign *VLAN*s to the instance of spanning tree on all switches.
- Assign region names in all switches.

Default Configurations

CONTEXT:

By default, only one spanning tree will be running on the bridge.

For other default MSTP configurations, refer to section 4.4.1 Default *MSTP* Configurations.

Configuration Steps

CONTEXT:

Refer to Figure Spanning Tree Topology for the topology setup.

By default, all switches will run Multiple Spanning Tree Protocol (*MSTP*).

1. Create *VLAN* 2, 3, and 4 with member ports as P1 and P2 on all switches.

   FOR EXAMPLE: Type the following:

   At Switch A:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Create *VLAN* 2

   ```
   iS5comm(config)# vlan 2
   ```

   – Configure P1 and P2 as member ports of the*VLAN* 2

   ```
   iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
   ```

   – Exit from the Vlan Configuration Mode

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

   – Create *VLAN* 3.

   ```
   iS5comm(config)# vlan 3
   ```

   – Configure P1 and P2 are member ports of the *VLAN* 2

   ```
   iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
   ```

   – Exit from the Vlan Configuration Mode

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

   – Create *VLAN* 4.

   ```
   iS5comm(config)# vlan 4
   ```

   – Configure P1 and P2 as member ports of the *VLAN* 2

   ```
   iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
   ```

   – Exit from the *VLAN* Configuration Mode

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

   – Configure P1 and P2 as member ports of the *VLAN* 2

   ```
   iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
   ```

   – Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 3.

```
iS5comm(config)# vlan 3
```

– Configure P1 and P2 are member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 4.

```
iS5comm(config)# vlan 4
```

– Configure P1 and P2 as member ports of the *VLAN* 2.

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

At Switch B:

– Enter the Global Configuration Mode

```
iS5comm# configure terminal
```

– Create VLAN 2

```
iS5comm(config)# vlan 2
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the Vlan Configuration Mode

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

– Create VLAN 3.

```
iS5comm(config)# vlan 3
```

– Configure P1 and P2 are member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the Vlan Configuration Mode

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

– Create *VLAN* 4.

```
iS5comm(config)# vlan 4
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the Vlan Configuration Mode

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

– Create *VLAN* 3.

```
iS5comm(config)# vlan 3
```

– Configure P1 and P2 are member ports of the VLAN 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the Vlan Configuration Mode

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

– Create *VLAN* 4.

```
iS5comm(config)# vlan 4
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

At Switch C:

– Enter the Global Configuration Mode

```
iS5comm# configure terminal
```

– Create *VLAN* 2

```
iS5comm(config)# vlan 2
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 3.

```
iS5comm(config)# vlan 3
```

– Configure P1 and P2 are member ports of the VLAN 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 4.

```
iS5comm(config)# vlan 4
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 3.

```
iS5comm(config)# vlan 3
```

– Configure P1 and P2 are member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

– Create *VLAN* 4.

```
iS5comm(config)# vlan 4
```

– Configure P1 and P2 as member ports of the *VLAN* 2

```
iS5comm(config-vlan)# ports gigabitethernet 0/1,0/2
```

– Exit from the *VLAN* Configuration Mode

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

Now, the*VLAN*s 2,3 4 are created with member ports P1 and P2 in all switches.

2. View the *VLAN* information on all switches A, B, and C using the following command.

FOR EXAMPLE: Type the following:

```
iS5comm# show vlan
```

Switch A:

```
iS5comm# show spanning-tree
Vlan database
-------------
Vlan ID             : 1
Member Ports        : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Untagged Ports      : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Forbidden Ports     : None
Name                :
Status              : Permanent
-------------------------------------------------
Vlan ID             : 2
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
-------------------------------------------------
Vlan ID             : 3
Member Ports        : Gi0/1, Gi0/2
```

```
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
------------------------------------------------
Vlan ID             : 4
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
------------------------------------------------
```

Switch B:

```
iS5comm# show spanning-tree
Vlan database
-------------
Vlan ID             : 1
Member Ports        : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Untagged Ports      : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Forbidden Ports     : None
Name                :
Status              : Permanent
------------------------------------------------
Vlan ID             : 2
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
------------------------------------------------
Vlan ID             : 3
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
```

```
Name                :
Status              : Permanent
-----------------------------------------------------
Vlan ID             : 4
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
-----------------------------------------------------
```

Switch C:

```
iS5comm# show spanning-tree
Vlan database
-------------
Vlan ID             : 1
Member Ports        : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Untagged Ports      : Gi0/1, Gi0/2, Gi0/3, Gi0/4, Gi0/5, Gi0/6
                      Gi0/7, Gi0/8, Gi0/9, Gi0/10, Gi0/11, Gi0/12
                      Gi0/13, Gi0/14, Gi0/15, Gi0/16, Gi0/17, Gi0/18
                      Gi0/19, Gi0/20, Gi0/21, Gi0/22, Gi0/23, Gi0/24
Forbidden Ports     : None
Name                :
Status              : Permanent
-----------------------------------------------------
Vlan ID             : 2
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
-----------------------------------------------------
Vlan ID             : 3
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
```

```
-------------------------------------------------
Vlan ID             : 4
Member Ports        : Gi0/1, Gi0/2
Untagged Ports      : None
Forbidden Ports     : None
Name                :
Status              : Permanent
-------------------------------------------------
```

3. Create Instance 1, 2, and 3 and assign *VLAN* 2, 3, and 4 respectively on all switches.

   FOR EXAMPLE: Type the following:

   At Switch A:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Enter the *MST* Configuration Mode.

   ```
   iS5comm(config)# spanning-tree mst configuration
   ```

   – Create *MSTP* Instance 1 and assign *VLAN* 2 to the *MSTP* Instance 1.

   ```
   iS5comm(config-mst)#instance 1 vlan 2
   ```

   – Create *MSTP* Instance 2 and assign *VLAN* 3 to the *MSTP* Instance 2

   ```
   iS5comm(config-mst)#instance 2 vlan 3
   ```

   – Create *MSTP* Instance 3 and assign *VLAN* 4 to the *MSTP* Instance 3.

   ```
   iS5comm(config-mst)#instance 3 vlan 4
   ```

   – Exit from the *MST* Configuration Mode.

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

   At Switch B:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Enter the *MST* Configuration Mode.

   ```
   iS5comm(config)# spanning-tree mst configuration
   ```

   – Create *MSTP* Instance 1 and assign *VLAN* 2 to the *MSTP* Instance 1.

   ```
   iS5comm(config-mst)#instance 1 vlan 2
   ```

   – Create *MSTP* Instance 2 and assign *VLAN* 3 to the *MSTP* Instance 2

   ```
   iS5comm(config-mst)#instance 2 vlan 3
   ```

   – Create *MSTP* Instance 3 and assign *VLAN* 4 to the *MSTP* Instance 3.

   ```
   iS5comm(config-mst)#instance 3 vlan 4
   ```

   – Exit from the MST Configuration Mode.

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

   At Switch C:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

– Enter the *MST* Configuration Mode.

```
iS5comm(config)# spanning-tree mst configuration
```

– Create *MSTP* Instance 1 and assign VLAN 2 to the *MSTP* Instance 1.

```
iS5comm(config-mst)#instance 1 vlan 2
```

– Create *MSTP* Instance 2 and assign VLAN 3 to the *MSTP* Instance 2

```
iS5comm(config-mst)#instance 2 vlan 3
```

– Create *MSTP* Instance 3 and assign VLAN 4 to the *MSTP* Instance 3.

```
iS5comm(config-mst)#instance 3 vlan 4
```

– Exit from the MST Configuration Mode.

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

4. Configure the bridge priority for each instance, such that switch A becomes the root for spanning tree instance 1, switch B becomes the root for spanning tree instance 2 and switch C becomes the root for spanning tree instance 3.

   FOR EXAMPLE: Type the following:

   At Switch A:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Configure the Instance 1 priority as 0

   ```
   iS5comm(config)# spanning-tree mst 1 priority 0
   ```

   – Enter the *MST* Configuration Mode

   ```
   iS5comm(config)#spanning-tree mst configuration
   ```

   – Configure the mst region name as reg1

   ```
   iS5comm(config-mst)#name reg1
   ```

   – Exit from the *MST* Configuration Mode

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

   At Switch B:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

   – Configure the Instance 1 priority as 0

   ```
   iS5comm(config)# spanning-tree mst 1 priority 0
   ```

   – Enter the *MST* Configuration Mode

   ```
   iS5comm(config)#spanning-tree mst configuration
   ```

   – Configure the mst region name as reg1

   ```
   iS5comm(config-mst)#name reg1
   ```

   – Exit from the *MST* Configuration Mode

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

   At Switch C:

   – Enter the Global Configuration Mode

   ```
   iS5comm# configure terminal
   ```

– Configure the Instance 1 priority as 0

```
iS5comm(config)# spanning-tree mst 1 priority 0
```

– Enter the *MST* Configuration Mode

```
iS5comm(config)#spanning-tree mst configuration
```

– Configure the mst region name as reg1

```
iS5comm(config-mst)#name reg1
```

– Exit from the *MST* Configuration Mode

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

5. Execute the following command to view the Spanning Tree Instance information of all *MSTI* in all switches.

FOR EXAMPLE: Type the following:

Switch A

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
                Port       0 [0]
                This bridge is the root
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST01
Root Id     Priority   0
            Address    00:01:02:03:04:01
            This bridge is the root
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  0
            Address  00:01:02:03:04:01
```

```
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST02
Root Id     Priority   0
            Address    00:02:02:03:04:01
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
             Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Root         Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST03
Root Id     Priority   0
            Address    00:03:02:03:04:01
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Root         Forwarding   200000  128    SharedLan
```

Switch B

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
```

```
                Port 1 [Gi0/1]
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
           Address  00:01:02:03:04:01
           Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
           Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Root         Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST01
Root Id     Priority   0
           Address    00:01:02:03:04:01
           Max age 20 sec 0 cs, forward delay 15 sec 0 cs
           Hello Time 2 sec 0 cs
Bridge Id   Priority  0
           Address  00:01:02:03:04:01
           Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
           Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Root         Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST02
Root Id     Priority   0
           Address    00:02:02:03:04:01
           This bridge is the root
           Max age 20 sec 0 cs, forward delay 15 sec 0 cs
           Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
           Address  00:01:02:03:04:01
           Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
```

```
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan

MST03
Root Id     Priority   0
            Address    00:03:02:03:04:01
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Alternate    Forwarding   200000  128    SharedLan
Gi0/2  Root         Forwarding   200000  128    SharedLan
```

Switch C

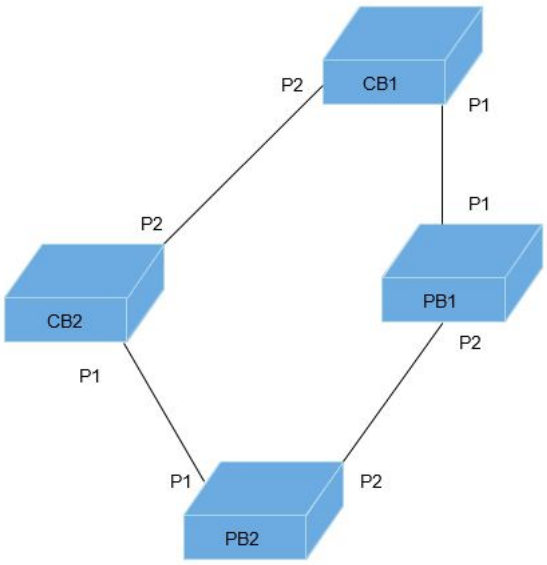
```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:01:02:03:04:01
                Cost       0
                Port 1 [Gi0/1]
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Root         Forwarding   200000  128    SharedLan
Gi0/2  Alternate    Discarding   200000  128    SharedLan

MST01
Root Id     Priority   0
            Address    00:01:02:03:04:01
```

```
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority 32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Root         Forwarding   200000  128    SharedLan
Gi0/2  Alternate    Discarding   200000  128    SharedLan

MST02
Root Id     Priority   0
            Address    00:02:02:03:04:01
            This bridge is the root
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
             Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Alternate    Forwarding   200000  128    SharedLan
Gi0/2  Root         Forwarding   200000  128    SharedLan

MST03
Root Id     Priority   0
            Address    00:03:02:03:04:01
            Max age 20 sec 0 cs, forward delay 15 sec 0 cs
            Hello Time 2 sec 0 cs
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan
```

7.3. Configuring Customer Edge Port Spanning Tree Operation

CONTEXT:

Figure 1: Provider Bridge Spanning Tree Topology



The guidelines for the configuration of multiple spanning tree protocol are as follows:

Switch PB1:

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

VLAN 1 - 10.0.0.1/255.0.0.0

Switch PB2:

MAC Address: 00:02:02:03:04:0

VLAN 1 – 10.0.0.2 /255.0.0.0

Switch CB1:

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

VLAN 1 – 10.0.0.10/255.0.0.0

Switch CB2:

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

VLAN 1 – 10.0.0.20/255.0.0.0

Configuration Guidelines

CONTEXT:

1) CB1 and CB2 should be configured as Customer Bridges.

2) PB1 and PB2 should be configured as Provider Edge Bridges. For configuration of bridge mode, refer to iS5Com Config User manual *VLAN*.
3) All bridges CB1, CB2, PB1, and PB2 should be configured to run Rapid Spanning Tree Protocol.
4) Configure P1 of PB1 and PB2 as Customer Edge Port.
5) Configure Service *VLAN* 2 with member ports as P1, P2 and untagged member ports as P1.
6) Configure *CVID* Registration table for creating logical port *PEP*s in the *C-VLAN* Spanning Tree in both PB1 and PB2.

Default Configurations

CONTEXT:

By default, only one spanning tree will be running on the bridge.

For other default *MSTP* configurations, refer to sections 3.7 Default Configurations and 4.4.1 Default *MSTP* Configurations.

Configuration Steps

CONTEXT:

Refer to Figure Provider Bridge Spanning Tree Topology for the topology setup.

By default, all switches will run Multiple Spanning Tree Protocol (*MSTP*).

1. By default, the bridge mode is Customer Bridge. So, configure PB1 and PB2 as Provider Edge Bridges.

   FOR EXAMPLE: Type the following:

   At Switch PB1:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Shutdown the spanning tree.

   ```
   iS5comm(config)# shutdown spanning-tree
   ```

   – Disable the *GVRP*.

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

   – Disable the *GMRP*.

   iS5comm(config)# set gmrp disable.

   – Shutdown the *GARP* application.

   ```
   iS5comm(config)# shutdown garp
   ```

   – Configure the bridge mode as provider-edge bridge.

   ```
   iS5comm(config)#bridge-mode provider-edge
   ```

   – Start the spanning tree.

   ```
   iS5comm(config)#spanning-tree mode mst
   ```

   – Start *GARP* application.

```
iS5comm(config)#no shutdown garp
```

– Enable *GVRP* protocol.

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

– Exit from the Global Configuration Mode.

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

At Switch PB2:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Shutdown the spanning tree.

```
iS5comm(config)# shutdown spanning-tree
```

– Disable the *GVRP*.

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

– Disable the *GMRP*.

iS5comm(config)# set gmrp disable

– Shutdown the *GARP* application.

```
iS5comm(config)# shutdown garp
```

– Configure the bridge mode as provider-edge bridge.

```
iS5comm(config)#bridge-mode provider-edge
```

– Start the spanning tree.

```
iS5comm(config)#spanning-tree mode mst
```

– Start *GARP* application.

```
iS5comm(config)#no shutdown garp
```

– Enable *GVRP* protocol.

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

– Exit from the Global Configuration Mode.

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

2. Verify the bridge mode is configured properly using the following command.

FOR EXAMPLE: Type the following:

```
iS5comm# show vlan device info
```

At switch PB1 and PB2:

```
Vlan device configurations
--------------------------
Vlan Status                    : Enabled
Vlan Oper status               : Enabled
Gvrp status                    : Enabled
Gmrp status                    : Disabled
Gvrp Oper status               : Enabled
Gmrp Oper status               : Disabled
```

```
Mac-Vlan Status                : Disabled
Protocol-Vlan Status           : Enabled
Bridge Mode                    : Provider Edge Bridge
Traffic Classes                : Enabled
Vlan Operational Learning Mode: IVL
Version number                 : 1
Max Vlan id                    : 4094
Max supported vlans            : 1024
```

3. Configure Rapid Spanning Tree Protocol in CB1 and CB2.

   FOR EXAMPLE: Type the following:

   At Switch CB1:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree mode as “rstp”.

   ```
   iS5comm(config)# spanning-tree mode rstp
   ```

   – Exit from the Global Configuration Mode.

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

   At Switch CB2:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree mode as “rstp”.

   ```
   iS5comm(config)# spanning-tree mode rstp
   ```

   – Exit from the Global Configuration Mode.

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

4. On PB1 and PB2, configure port P1 as Customer Edge Port (*CEP*). Refer to section Configuring Customer Spanning Tree Module Status for more information on customer edge ports.

   FOR EXAMPLE: Type the following:

   At Switch PB1:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the Interface Configuration Mode.

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

   – Configure port P1 as a Customer Edge Port (*CEP*).

   ```
   iS5comm(config-if)#bridge port-type customerEdgePort
   ```

   – Exit from the Interface Configuration Mode.

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

   At Switch PB2:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

– Enter the Interface Configuration Mode.

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

– Configure port P1 as a Customer Edge Port.

```
iS5comm(config-if)#bridge port-type customerEdgePort
```

– Exit from the Interface Configuration Mode.

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

NOTE: Now the Port P1 is configured as Customer Edge Port (*CEP*) in PB1 and PB2. A separate instance of RSTP will run on Port P1 in PB1 and PB2. Both the *CEP* has participated in the Customer Spanning tree and chose the Root as CB1.

5. On PB1 and PB2, create service-VLAN2 with member ports P1 & P2 and untagged port P1.

   FOR EXAMPLE: Type the following:

   At Switch PB1:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the *VLAN* Configuration Mode.

   ```
   iS5comm(config)# vlan 2
   ```

   – Configure Port P1, P2 as member port and P1 as untagged member port.

   ```
   iS5comm(config-vlan)#ports gigabitethernet 0/1,0/2 untagged
   gigabitethernet 0/1
   ```

   – Exit from the Interface Configuration Mode.

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

   At Switch PB2:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the *VLAN* Configuration Mode.

   ```
   iS5comm(config)# vlan 2
   ```

   – Configure Port P1, P2 as member port and P1 as untagged member port.

   ```
   iS5comm(config-vlan)#ports gigabitethernet 0/1,0/2 untagged
   gigabitethernet 0/1
   ```

   – Exit from the Interface Configuration Mode.

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

6. Configure *CVID* Registration table for *VLAN* 2 to create a Provider Edge Port (*PEP*) in the customer Spanning-tree.

   FOR EXAMPLE: Type the following:

   At Switch PB1:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the Interface Configuration Mode.

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

– Configure the *CVID* Registration table for the service VLAN 2.

```
iS5comm(config-if)#switchport customer-vlan 2 service-vlan 2
```

– Exit from the Interface Configuration Mode.

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

At Switch PB2:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Enter the Interface Configuration Mode.

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

– Configure the *CVID* Registration table for the service VLAN 2.

```
iS5comm(config-if)#switchport customer-vlan 2 service-vlan 2
```

– Exit from the Interface Configuration Mode.

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

NOTE: Now the *PEP* will be created, and it will also be participating in the customer spanning-tree and appropriate port roles will be selected for the *PEP*.

7. Execute the following command to view the *PEP* Port roles and state.

FOR EXAMPLE:

Type the following:

At Switch PB1

```
iS5comm# show spanning-tree
Root Id          Priority   32768
                 Address    00:03:02:03:04:01
                 Cost       200000
                 Root Ports  Gi0/1
                 Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                 Forward Delay 15 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id        Priority 0
                 Address 00:01:02:03:04:01
                 Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                 Forward Delay 15 Sec 0 cs
Name           Role        State       Cost   Prio Type
----           ----        -----       ----   ---- ----
PEP-Service: 2 Designated  Discarding  128    32   SharedLan
CEP-Gi0/1      Root        Forwarding  200000 32   SharedLan
```

At Switch PB2

```
iS5comm# show spanning-tree
Root Id          Priority   32768
                 Address    00:03:02:03:04:01
```

```
                Cost       200000
                Root Ports Service: 2
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP
Bridge Id       Priority 0
                Address 00:01:02:03:04:01
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
Name           Role        State        Cost     Prio   Type
----           ----        -----        ----     ----   ----
PEP-Service: 2 Designated  Discarding   128      32     SharedLan
CEP-Gi0/1      Root        Forwarding   200000   32     SharedLan
```

NOTE: Provider Bridge Spanning tree does not interact with the *C-VLAN* Spanning tree.

8. Execute the following command to view the Provider Spanning tree.

FOR EXAMPLE: Type the following:

At Switch PB1

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:03:02:03:04:01
Cost       0
Port       0 [0]               This bridge is the root
                Max age 20 sec 0 cs, forward delay 15 sec 0 cs
                Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol Enabled.
S-VLAN Component: MST00 is executing the mstp compatible Multiple
Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs

Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Disabled     Discarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan
```

FOR EXAMPLE: **At Switch PB2**

```
iS5comm# show spanning-tree
Root Id         Priority   32768
```

```
Address    00:03:02:03:04:01
Cost 200000
Port 2 [Gi0/2]
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
Spanning tree Protocol Enabled.
S-VLAN Component: MST00 is executing the mstp compatible Multiple
Spanning Tree Protocol
Bridge Id   Priority  32768
            Address  00:01:02:03:04:01
            Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
            Hello Time is 2 sec 0 cs

Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Disabled     Discarding   200000  128    SharedLan
Gi0/2  Root         Forwarding   200000  128    SharedLan
```

NOTE: *CEP* will be disabled in the provider bridge spanning tree topology.

9. Now, view the Customer Network topology in bridges PB1, PB2, CB1, and CB2.

   FOR EXAMPLE: Type the following:

   At Switch CB1

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:03:02:03:04:01
Cost       0
Port       0 [0]
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:03:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Designated   Forwarding   200000  128    SharedLan
```

   At Switch CB2

```
iS5comm# show spanning-tree
```

```
Root Id         Priority   32768
                Address    00:03:02:03:04:01
Cost       200000
Port       0 [0]
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:03:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name   Role         State        Cost    Prio   Type
----   ----         -----        ----    ----   -----
Gi0/1  Designated   Forwarding   200000  128    SharedLan
Gi0/2  Root         Forwarding   200000  128    SharedLan
```

At Switch PB1

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:03:02:03:04:01
Cost       200000
Port       Gi0/1
Max Age 20 sec 0 cs,
Forward Delay 15 sec 0 cs
Customer Spanning Tree Enabled Protocol RSTP

Bridge Id       Priority 0
                Address 00:03:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Name              Role         State        Cost     Prio   Type
----              ----         -----        ----     ----   -----
PEP-Service: 2    Designated   Forwarding   128      32     SharedLan
CEP-Gi0/1         Root         Forwarding   200000   32     SharedLan
```

At Switch PB2

```
iS5comm# show spanning-tree
Root Id         Priority   32768
                Address    00:03:02:03:04:01
Cost 200128
Root Ports Service: 2
                Hello Time 2 Sec 0 cs, Max Age 20 Sec 0 cs,
                Forward Delay 15 Sec 0 cs
```

```
Customer Spanning Tree Enabled Protocol RSTPBridge Id       Priority 0
               Address 00:02:02:03:04:01
               Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs,
               Forward Delay 15 sec 0 cs
Name             Role         State        Cost     Prio   Type
----             ----         -----        ----     ----   -----
PEP-Service: 2   Root         Forwarding   128      32     SharedLan
CEP-Gi0/1        Alternate    Discarding   200000   32     SharedLan
```

Configuration for Achieving Flush Optimization

8. Configuration for Achieving Flush Optimization

Configurations for achieving flush optimization are applicable for a *MSTP* module. Flush optimization is implemented by optimizing the number of flush indications triggered per instance basis during topology change, instance creation/deletion, and mapping/ unmapping of *VLAN* to instance. This is achieved using flush interval time value and per-instance based flush indication threshold value. These values allow the administrator to configure the flush interval time through which flush optimization can be enabled / disabled.

- If a flush interval is maintained with its default value, flush optimization will be disabled (for backward compatibility). If a flush interval has a non-default value, flush optimization will be considered as enabled. Flush optimization also depends on the status of flush interval timer and flush indication threshold when flush interval's value is non-default.
- A flush interval timer is maintained per instance basis. If the timer is running, flush indications will be blocked, and for that specific instance, instance-based flushing will be triggered during timer expiry.

Flush indication threshold indicates the number of flush indications to go before flush interval timer method triggers. Instance based flushing is triggered when the flush Indication threshold is configured at its default value. Counters for tracking the number of per instance based flush indications invoked during the topology change, instance creation/deletion, and mapping/unmapping of *VLAN* to an instance are also maintained.

8.1. Configuring Flush Interval

Configuration of a flush interval allows enabling or disabling flush optimization, which is based upon the flush interval value. The configuration is applicable per switch (context) basis.

1. Configure a flush interval value for a default switch as 200 cs (20 centi-seconds).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# configure terminal
   iS5comm(config)# spanning-tree flush-interval 20
   iS5comm(config)#end
   ```

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

   ```
   iS5comm# show spanning-tree detail
   ```

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
bpdu-receive enabled
Loop Guard is disabled
```

2. Configuring flush interval value for default switch as default value (0).

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# no spanning-tree flush-interval
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
```

In Switch A

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
```

```
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
bpdu-receive enabled
Loop Guard is disabled
```

3. Configuring flush interval value for MSTI-1 in “default” switch as.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 2
iS5comm(config- mst)# end
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# spanning-tree mst 1 flush-indication-threshold 2
iS5comm(config)# no spanning-tree flush-interval
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
 ..................................
bpdu-receive enabled
Loop Guard is disabled

MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 0
Flush Indication threshold 2
.......................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

4. Configuring flush interval value for MSTI-1 in a default switch as default value (0).

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# no spanning-tree mst 1 flush-indication-threshold
iS5comm(config-mst)# end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
 ................................
bpdu-receive enabled
Loop Guard is disabled

MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 0
Flush Indication threshold 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

8.2. Configuring Flush Indication Threshold

CONTEXT:

Flush Indication threshold for a specific instance is the number of flush indications before triggering the flush interval timer, whenever a flush indication is triggered for an instance. When the value is set as default value, instance-based flushing is triggered instead of port-instance based flushing. When threshold is not reached, then port-instance based flushing is triggered. Flush interval timer will be started in both of the above cases. Hence during timer expiry, instance-based flushing will be triggered to clear any pending flushes (if applicable).

1. Configure a flush indication threshold value for CIST in a default switch as 1.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# spanning-tree flush-indication-threshold 1
```

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

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

```
iS5comm# show spanning-tree detail
```

In Switch A

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 1
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
bpdu-receive enabled
Loop Guard is disabled
```

– Execute the no spanning-tree priority from the Global Configuration mode command to set the Priority to its default value.

```
iS5comm(config)#no spanning-tree priority
```

2. Configuring flush interval value for default switch as default value (0).

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# no spanning-tree flush-interval
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
```

In Switch A

```
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 0 centi-sec, Flush Invocations 0
```

```
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
bpdu-receive enabled
Loop Guard is disabled
```

8.3. How to Achieve Flush Optimization

CONTEXT:

This section explains the different scenarios for achieving flush optimization in *MSTP*. In the listed scenarios, flush optimization can be validated using flush count for each instance. The topology used is a single *DUT* with 5 ports as non-edge ports. The ports should be up and spanning-tree should be enabled on those ports.

Scenario 1: (Default Flush Interval & Flush Indication Threshold)

This scenario explains a default behavior without flush optimization. It is retained as the default behavior for backward compatibility.

1. Configure flush interval value for a default switch as a default value (0).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# configure terminal
   iS5comm(config)# no spanning-tree flush-interval
   iS5comm(config)#end
   ```

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

   ```
   iS5comm# show spanning-tree detail
   MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
   Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
   Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
   Configured Hello Time 2 sec 0 cs
   Dynamic Path Cost Disabled
   Flush Interval  0 centi-sec, Flush Invocations 0
   Flush Indication threshold 0
   ```

```
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
bpdu-receive enabled
Loop Guard is disabled
```

2. Create *VLAN* 2, 3 with member ports as gigabitethernet 0/1-5 and clear the spanning-tree counters, which reset the flush invocations count to zero.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# vlan 2
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# vlan 3
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# clear spanning-tree counters
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  0 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
```

```
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
```

3. Create instance 1 and map *VLAN* 2 to that instance.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 2
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  0 centi-sec, Flush Invocations 5
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 10
Flush Indication threshold 0
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
```

```
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

4. Map the *VLAN* 3 to the existing instance 1.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# clear spanning-tree counters
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 3
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  0 centi-sec, Flush Invocations 5
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
```

```
MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 10
Flush Indication threshold 0
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

Scenario 2: (Non-Default Flush Interval & Default Flush Indication Threshold)

This scenario explains the flush optimization when flush interval is maintained as non-default value and flush indication threshold is maintained as default value (0). This is a special case, where instance-based flushing is triggered; whenever, instance-based flushing is triggered for the first time (when flush-indication threshold is maintained as zero). On timer expiry, again instance based flushing will be triggered to clear the pending flushes.

1. Configure flush interval value for as 200 ms (20 cs).

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# no spanning-tree flush-indication-threshold
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
```

```
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
.........................
bpdu-receive enabled
Loop Guard is disabled
```

2. Create a VLAN 2 with member ports as gi 0/1-5 and clear the spanning-tree counters, which reset the flush invocations count to 0.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# vlan 2
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# vlan 3
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# clear spanning-tree counters
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
```

```
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
```

3. Create instance 1 and map *VLAN* 2 to that instance.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 2
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 5
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 10
Flush Indication threshold 0
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
```

```
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

4. Map the *VLAN* 3 to the existing instance 1.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# clear spanning-tree counters
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 3
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 5
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
```

```
MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 2
Flush Indication threshold 0
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

Scenario 3: (Non-Default Flush Interval & Flush Indication Threshold)

This scenario explains the flush optimization when both flush interval and flush indication threshold are maintained at non-default value (1).

1. Configure flush interval value for as 200 ms (20 cs).

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree flush-interval 20
iS5comm(config)# spanning-tree flush-indication-threshold 1
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 1
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
```

```
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
.........................
bpdu-receive enabled
Loop Guard is disabled
```

2. Create a *VLAN* 2 with member ports as gi 0/1-5 and clear the spanning-tree counters, which reset the flush invocations count to 0.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# vlan 2
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# vlan 3
iS5comm(config-vlan)# ports gigabitethernet 0/1-5
iS5comm(config-vlan)# exit
iS5comm(config)# clear spanning-tree counters
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 0
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
```

```
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled
```

3. Create instance 1 and map *VLAN* 2 to that instance.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 2
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 5
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
.........................
bpdu-receive enabled
Loop Guard is disabled

MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 2
Flush Indication threshold 0
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
```

```
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.....................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

4. Configure the flush indication threshold of instance 1 as 2 and map the *VLAN* 3 to the existing instance 1.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# clear spanning-tree counters
iS5comm(config)# spanning-tree mst 1 flush-indication-threshold 2
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 3
iS5comm(config-mst)# instance 1 vlan 3
iS5comm(config-mst)#end
```

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

```
iS5comm# show spanning-tree detail
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval  20 centi-sec, Flush Invocations 5
Flush Indication threshold 1
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 0, Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Root Times : Max age 20 sec 0 cs     Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs
```

```
.........................
bpdu-receive enabled
Loop Guard is disabled

MST01 is executing mstp compatible spanning-tree protocol
Flush Invocations 3
Flush Indication threshold 2
Port 1 [Gi0/1]of MST01 is Designated, Discarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers:Hello - 1,Forward Delay - 11,Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 5, received 0
.......................
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 0
BPDUs : sent 6, received 0
```

Configuration for Port Creation/ Deletion at STP Module Level

9. Configuration for Port Creation/ Deletion at STP Module Level

In an existing *STP* module, when a port is mapped to any context, a corresponding port is created in the *STP* module. This is irrespective of whether *STP* is intended to be enabled on that interface, and as a result leads to *STP* scaling issues. This problem is solved by having control on the port entry creation in the *STP* module itself.

To maintain backward compatibility for this behavior, a flag AUTOMATIC_PORT_CREATE is included in NVRAM file.

To create or delete ports at *STP* module level, the automatic port create feature should be disabled. The default value is enabled.

9.1. Scenario 1: Creation/deletion of port at RSTP Module

1. Create a physical port at a *RSTP* module.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
Spanning Tree protocol enabled was MST. Now MST is being shut down and
RST is being enabled.
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
```

```
                Port       0
                 Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:07:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role        State         Cost     Prio   Type
----    ----        -----         ----     ----   ------
Gi0/1   Designated  Forwarding    200000   128    SharedLan
```

2. Delete a physical port at RSTP module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0
                Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:07:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role      State      Cost     Prio   Type
----    ----       -----    ----     ----     ------
```

3. Create a logical port at *RSTP* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
```

```
Spanning Tree protocol enabled was MST. Now MST is being shut down and
RST is being enabled.
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# set port-channel enable
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# channel-group 1 mode active
iS5comm(config-if)# exit
iS5comm(config)# int port-channel 1
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0
                Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:07:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
po1     Designated   Forwarding   199900   128    P2P
```

4. Delete a logical port at *RSTP* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0
                Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
                Address 00:07:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role      State      Cost     Prio   Type
----    ----       -----    ----     ----     ------
```

9.2. Scenario 2: Creation/deletion of port at MSTP Module

1. Create a physical port at an *MSTP* module.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode mst
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port 0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
```

```
Bridge Id       Priority  32768
                Address  00:07:02:03:04:01
                Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
                Hello Time is 2 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role        State       Cost     Prio     Type
----    ----        -----       ----     ----     ------
Gi0/1   Designated  Forwarding  200000   128      SharedLan
```

2. Delete a physical port at *MSTP* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
                Address  00:07:02:03:04:01
                Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
                Hello Time is 2 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role      State      Cost     Prio   Type
----    ----       -----    ----     ----     ------
```

3. Create a logical port at *MSTP* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode mst
```

```
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# set port-channel enable
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# channel-group 1 mode active
iS5comm(config-if)# exit
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
                Address  00:07:02:03:04:01
                Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
                Hello Time is 2 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role        State       Cost     Prio     Type
----    ----        -----       ----     ----     ------
po1     Designated  Forwarding  199900   128      P2P
```

4. Delete a logical port at *MSTP* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no spanning-tree
```

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

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

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs

MST00
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
                Address  00:07:02:03:04:01
                Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
                Hello Time is 2 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name    Role      State      Cost     Prio   Type
----    ----       -----    ----     ----     -----
```

9.3. Scenario 3: Creation/deletion of port at PVRST Module

1. Create a physical port at a *PVRST* module.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# set gvrp disable
iS5comm(config)# spanning-tree mode pvrst
Spanning Tree enabled protocol is MSTP, now MSTP is being shutdown
PVRST is started.
PVRST Module status is changed
iS5comm(config)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
```

```
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port 0
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name   Role         State        Cost     Prio   Type
----   ----         -----        ----     ----   -----
Gi0/1  Designated   Forwarding   200000   128    SharedLan
```

2. Delete a physical port at *PVRST* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
-----------------------------------------------------
Spanning-tree for VLAN 1
We are the root of the Spanning Tree
Root Id         Priority   32769
 Address    00:01:02:03:04:01Cost       0
Port       0
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
                Address 00:01:02:03:04:01                Hello Time 2
sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
```

```
Name   Role         State        Cost     Prio   Type
----   ----         -----        ----     ----   -----
```

3. Create a logical port at *PVRST* module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# set gvrp disable
iS5comm(config)# spanning-tree mode pvrst
PVRST is started.PVRST Module status is changed
iS5comm(config)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# no shutdown
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# channel-group 1 mode active
iS5comm(config-if)# exit
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
Spanning-tree for VLAN 1
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
Port       0
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name   Role         State        Cost     Prio   Type
----   ----         -----        ----     ----   -----
po1    Designated   Forwarding   199900   128    P2P
```

4. Delete a logical port at PVRST module.

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface port-channel 1
iS5comm(config-if)# no spanning-tree
iS5comm(config-if)# end
```

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

```
iS5comm# show spanning-tree
Spanning-tree for VLAN 1
We are the root of the Spanning Tree
Root Id         Priority   32768
                Address    00:07:02:03:04:01
                Cost       0
               Port       0
 Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
                Address 00:01:02:03:04:01
                Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
                Forward Delay 15 sec 0 cs
                Dynamic Path Cost is Disabled
                Dynamic Path Cost Lag-Speed Change is Disabled
Name   Role         State        Cost     Prio   Type
----  ----         -----        ----     ----   ------
```

Configuration of Spanning Tree Guard

10. Configuration of Spanning Tree Guard

IS5Com *STP* provides support for the following guard features as per the industry standards.

- Root guard for *RSTP*, *MSTP*, and *PVRST*
- *BPDU* guard for *RSTP*, *MSTP*, and *PVRST*
- Loop guard for RSTP, *MSTP*, and *PVRST*

10.1. Configuring Root Guard

Root guard can be configured on an interface level in *RSTP*, *MSTP*, and *PVRST*. The root guard prevents a port in a Designated port role to transition to a Root port role on reception of superior information; thereby, a root guard maintains the same bridge role as Root.

Configuration Example in RSTP

1. Configure *RSTP*.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
Spanning Tree protocol enabled is MST. Now MST is being shutdown and RST
is being enabled
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree link-type point-to-point
iS5comm(config-if)# spanning-tree guard root
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Port 1 [Gi0/1] is Designated, Forwarding
Port PathCost 200000, Port Priority 128, Port Identifier  128.1
```

```
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated PathCost 0
No of Transitions to forwarding State :1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
LinkType is point to Point
BPDUs : sent 133 , received 7
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0,
Error Disable Recovery Interval 300 sec 0 cs
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is enabled.
Loop Guard is disabled.
```

– On reception of superior information on this port, the port transitions to Root Inconsistent role; a Console Message showing the transition is as follows:

AST: Spanning-tree Root_Guard_Block: Root Guard feature blocking Port: 1

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:02:02:03:04:01
Cost       200000
Port       Gi0/2
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning tree Protocol Enabled.
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
Address 00:01:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Designated   Discarding   200000   128    P2P(*Root-Inc)
Gi0/2     Root         Forwarding   200000   128    P2P
```

Configuration Example in MSTP

1. Configure *MSTP*.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode mst
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree guard root
iS5comm(config-if)# spanning-tree guard root
iS5comm(config)#end
```

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

```
iS5comm# show spanning-tree detail
Spanning tree Protocol has been enabled
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 0 centi-sec, Flush Invocations 25
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 2, Time since topology Change 248 seconds ago
Transmit Hold-Count 6
Root Times : Max age 20 sec 0 cs         Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
```

```
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 184, received 133
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is enabled
Loop Guard is disabled
Port 2 [Gi0/2] of MST00 is Designated, Forwarding
Gi0/2 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.2. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.2, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 149, received 125
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is enabled
Loop Guard is disabled
```

– On reception of Superior *BPDU*s to the switch, the following port role/state is observed: a Console Message showing the transition is as follows:

AST: Spanning-tree Root_Guard_Block : Root Guard feature blocking Port: 1: Inst 0

AST: Spanning-tree Root_Guard_Block : Root Guard feature blocking Port: 2: Inst 0

```
iS5comm# show spanning-tree
Root Id         Priority   0
Address    00:02:02:03:04:01
Cost       200000
Port       0 [0]
This bridge is the root
```

```
Max age 20 sec 0 cs, forward delay 15 sec 0 csHello Time 2 sec 0
csMST00Spanning tree Protocol has been enabledMST00 is executing the
mstp compatible Multiple Spanning Tree ProtocolBridge Id       Priority
32768Address  00:01:02:03:04:01Max age is 20 sec 0 cs, forward delay is
15 sec 0 cs
Hello Time is 2 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------

Gi0/1     Designated   Discarding   200000   128    SharedLan(*Root-Inc)
Gi0/2     Designated   Discarding   200000   128    SharedLan(*Root-Inc)
```

Configuration Example in PVRST

In PVRST, a prerequisite for configuring of a port to be enabled Root Guard is that the port is a trunk port.

1. Configure PVRST.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode pvrst
Spanning Tree enabled protocol is MSTP, now MSTP is being shutdown
PVRST is started.
PVRST Module status is changed
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# switchport mode trunk
Pvrst RootGuard is Enabled
iS5comm(config)#end
```

   – On reception of per *VLAN* superior *BPDU*s, the state of the port moves to Root Inconsistent. View the spanning tree information by executing the following show command.

```
iS5comm# show spanning-tree
Spanning-tree for VLAN 1
Root Id         Priority   0
Address    00:02:02:03:04:01
Cost       200000
Port       Gi0/2
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32768
```

```
Address 00:01:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Designated   Discarding   200000   128    P2P(*Root-Inc)
Gi0/2     Root         Forwarding   200000   128    P2P)
```

NOTE: Root Guard feature behaves per Instance in case of *MSTP* and per *VLAN* in case of PVRST.

– To disable Root Guard on a port by configuration, the following command is used:

```
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost 200000, Port priority 128,
Port Identifier 128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 52, received 48
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is enabled
Loop Guard is disabled
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree guard none
iS5comm(config-if)# end
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
```

```
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 64, received 60
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled
Loop Guard is disabled
```

10.2. Configuring BPDU Guard

CONTEXT:

BPDU Guard feature prevents the forwarding state transition on ports which are *BPDU* Guard enabled when a *BPDU* is received on that port. This feature puts the port in Disabled/Discarding state which is termed the "Error Disable" state.

For a port to recover from Disabled/Discarding state,

- the port has to be manually brought up, or
- the port can recover automatically.

BPDU Guard feature can be enabled globally as well as on an interface basis in all 3 modes of STP.

Sample Configuration of Global BPDU Guard (In a WorkGroup exe)

1. To enable *BPDU* Guard, the following configuration is done at global level. (*MSTP* example).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# configure terminal
   iS5comm(config)# spanning-tree mode mst
   ```

   Spanning Tree enabled protocol is *RSTP*, now *RSTP* is being shutdown and *MSTP* is being enabled.

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

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree portfast bpduguard default
iS5comm(config)# end
```

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

```
iS5comm# show spanning-tree detail
Spanning-tree portfast bpduguard enabled
Spanning tree Protocol has been enabled
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Identifier has Priority 32768, Address 00:01:02:03:04:01
Configured  Max age 20 sec 0 cs,  Forward delay 15 sec 0 cs
Configured Hello Time 2 sec 0 cs
Dynamic Path Cost Disabled
Flush Interval 0 centi-sec, Flush Invocations 24
Flush Indication threshold 0
We are root of the spanning tree
Current Root has priority 32768, address  00:01:02:03:04:01
cost of root path is 0
Number of Topology Changes 1, Time since topology Change 447 seconds ago
Transmit Hold-Count 6
Root Times : Max age 20 sec 0 cs         Forward delay 15 sec 0 cs
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 234, received 230
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled
Loop Guard is disabled
```

Sample Configuration of BPDU Guard on an Interface (in RSTP)

1. Following is a sample configuration for enabling *BPDU* Guard in *RSTP* in an interface.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
Spanning Tree protocol enabled is MST. Now MST is being shutdown and RST
is being enabled.
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config)# spanning-tree bpduguard enable
RstpBpduguard Enabled
iS5comm(config)# end
```

   – The configuration can be verified with the following display command.

```
iS5comm# show spanning-tree
We are the root of the Spanning Tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       0
Port       0
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning tree Protocol Enabled.
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
Address 00:01:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name              Role         State        Cost     Prio   Type
----              ----         -----        ----     ----   ------
Gi0/1             Disabled     Discarding   200000   128    SharedLan
```

Configuration of Error Disable Recovery Timer

CONTEXT:

The Error Disable Recovery Timer is a per-port timer that is run on a port for 300 seconds by default, on reaching the Error Disabled state.

This timer interval can be configured in the range of 300-65535 seconds.

NOTE: It is to be noted that the *PVRST BPDU* Guard feature supports recovery from Error Disable state only by manual enabling of ports and not by configuring this Error Disable Recovery Timer.

The following is a sample configuration of the Error Disable Recovery Timer in *MSTP*.

1. The following is a sample configuration of the Error Disable Recovery Timer in *MSTP*.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode mst
```

   Spanning Tree enabled protocol is *RSTP*, now *RSTP* is being shutdown and *MSTP* is being enabled.

```
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# errordisable recovery-interval 400iS5comm(config-if)#
end
iS5comm(config)# end
```

   – The configuration can be verified with the following display command.

```
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Port 1 [Gi0/1] of MST00 is Designated, Forwarding
Gi0/1 is operating in the MSTP Mode
Port path cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 400 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 1
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 13, received 13
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled
Loop Guard is disabled
```

10.3. Configuring Loop Guard

CONTEXT:

Loop Guard feature prevents temporary loops in network which are caused when non-designated ports transition to Forwarding state due to a link failure in the topology.

Loop Guard is configured on a port which is Point-to-Point link type.

Loop Guard does not have any impact on port role/state in case of a Designated Port. Loop guard checks if a root port or an alternate root port receives *BPDU*s. If the port is receiving *BPDU*s, loop guard puts the port into an loop-inconsistent state (Designated / Discarding) until it starts receiving *BPDU*s again.

When you enable a Loop Guard, it is automatically applied to all of the active instances or *VLAN*s to which that port belongs. When you disable loop guard, it is disabled for the specified ports. Disabling a Loop Guard moves all loop-inconsistent ports to the listening state.

Sample Configuration of Loop Guard on an Interface (in RSTP)

1. In the absence of *BPDU*s, configuring Loop Guard on a non-designated port puts the port in Loop-Inconsistent State (Designated / Discarding).

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
Spanning Tree protocol enabled is MST. Now MST is being shutdown and RST
is being enabled.
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config)# spanning-tree link-type point-to-point
iS5comm(config-if)# spanning-tree loop-guard
iS5comm(config)# end
```

   – The configuration can be verified with the following display command.

```
iS5comm# show spanning-tree interface gigabitethernet 0/2 detail
Port 2 [Gi0/2] is Alternate , Discarding
Port PathCost 200000, Port Priority 128, Port Identifier  128.2
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.2, Designated PathCost 0
Received Hello Time 2 sec 0 cs
No of Transitions to forwarding State :0
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
LinkType is point to Point
```

```
BPDUs : sent 170 , received 39
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0,
Error Disable Recovery Interval 300 sec 0 cs
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled.
Loop Guard is enabled.
```

– In the absence of *BPDU*s, the following transition is seen:

AST: Spanning-tree Loop-guard feature blocking Port: 2

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
Port       Gi0/1
Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning tree Protocol Enabled.
Bridge is executing the rstp compatible Rapid Spanning Tree Protocol
Bridge Id       Priority 32768
Address 00:02:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs
Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Root         Forwarding   200000   128    P2P
Gi0/2     Designated   Discarding   200000   128    P2P(*Loop-Inc)
```

To disable the Loop guard feature on the port 0/2, the following command is performed.

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config-if)# no spanning-tree loop-guard
iS5comm(config-if)# end
```

Sample Configuration of Loop Guard in MSTP

1. Following is a sample configuration of Loop Guard on a port, in a multiple *MST* Instance (*CIST* & 2 *MSTI*s) scenario.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode mst
Spanning Tree enabled protocol is RSTP, now RSTP is being shutdown and
MSTP is being enabled.
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# spanning-tree mst configuration
iS5comm(config-mst)# instance 1 vlan 10
iS5comm(config-mst)# instance 2 vlan 20
iS5comm(config-mst)# name region
iS5comm(config-mst)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree link-type point-to-point
iS5comm(config-if)# spanning-tree loop-guard
iS5comm(config)# end
```

– The configuration can be verified with the following display command.

```
iS5comm# show spanning-tree interface gigabitethernet 0/1 detail
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1, Forward Delay - 0, Topology Change - 0
Error Disable Recovery Interval 300 sec 0 cs
Designated root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 4
Auto-Edge is disabled
PortFast is disabled, Oper-Edge is disabled
Link type is point to Point
BPDUs : sent 179, received 132
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled
Loop Guard is enabled
Port 1 [Gi0/1]of MST01 is Root, Forwarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1,Forward Delay - 0, Topology Change - 0
```

```
Designated Root has priority 0, address 00:02:02:03:04:01
Designated Bridge has priority 0, address 00:02:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 3
BPDUs : sent 74, received 33
Port 1 [Gi0/1]of MST02 is Designated, Forwarding
Port cost  200000, Port priority  128,
Port Identifier  128.1. Port HelloTime  2 sec 0 cs,
Timers: Hello - 1,Forward Delay - 0, Topology Change - 0
Designated Root has priority 32768, address 00:01:02:03:04:01
Designated Bridge has priority 32768, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated pathcost is 0
Operational Forward delay 15 sec 0 cs, Max age 20 sec 0 cs
Number of Transitions to forwarding State : 2
BPDUs : sent 67, received 32
```

– In the absence of *BPDUs*, the following transition is seen:

AST: Spanning-tree Loop-guard feature blocking Port: 1 for Instance: 1

```
iS5comm# show spanning-tree
Root Id         Priority   32768
Address    00:01:02:03:04:01
Cost       200000
Port       0 [0]
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time 2 sec 0 cs
MST00
Spanning tree Protocol has been enabled
MST00 is executing the mstp compatible Multiple Spanning Tree Protocol
Bridge Id       Priority  32768
Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Designated   Forwarding   200000   128    P2P (*Loop-Inc)
Gi0/2     Designated   Forwarding   200000   128    P2P
```

```
MST01
Root Id         Priority   0
Address    00:02:02:03:04:01
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time is 2 sec 0 cs
Bridge Id       Priority  32768
Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Designated   Discarding   200000   128    P2P  (*Loop-Inc)
Gi0/2     Root         Forwarding   200000   128    P2P
MST02
Root Id         Priority   32768
Address    00:01:02:03:04:01
This bridge is the root
Max age 20 sec 0 cs, forward delay 15 sec 0 cs
Hello Time is 2 sec 0 cs
Bridge Id       Priority  32768
Address  00:01:02:03:04:01
Max age is 20 sec 0 cs, forward delay is 15 sec 0 cs
Hello Time is 2 sec 0 cs
Name      Role         State        Cost     Prio   Type
----      ----         -----        ----     ----   ------
Gi0/1     Designated   Forwarding   200000   128    P2P  (*Loop-Inc)
Gi0/2     Designated   Forwarding   200000   128    P2P
```

Sample Configuration of Loop Guard in PVRST

CONTEXT:

Loop guard configuration can be applied on Access, Trunk & Hybrid ports in *PVRST*. However, since the hybrid ports are not interoperable with industry standards, the behaviour of hybrid ports is not defined with this implementation of loop guard.

Below is a sample configuration of Loop Guard on trunk ports.

Consider a sample topology with 2 switches connected across by 2 redundant links. Each port in the setup is a trunk port with 3 *VLAN*s active in the topology - *VLAN*s 1, 2 & 3. For *VLAN*s 1 & 3, switch 1 in the

topology is the Root, while for *VLAN* 2, switch 2 is the root. The loop guard configuration is applied on the port 0/1 of switch 2.

1. Perform the following commands.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode pvrst
Spanning Tree enabled protocol is MSTP, now MSTP is being shutdown
PVRST is started.
PVRST Module status is changed
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# vlan 2
iS5comm(config-vlan)# vlan active
iS5comm(config-vlan)# exit
iS5comm(config)# vlan 3
iS5comm(config-vlan)# vlan active
iS5comm(config-vlan)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree link-type point-to-point
iS5comm(config-if)# switchport mode trunk
iS5comm(config-if)# spanning-tree guard loop
iS5comm(config-if)# end
```

NOTE: It is to be noted that the command for configuring loop guard in *PVRST* is "spanning-tree guard loop". In *PVRST*, the granularity of Loop Guard function is per *VLAN* per Port, rather than per port.

In the absence of *VLAN* specific *BPDU*s, the port goes to Loop-inconsistent state as follows:

AST: Spanning-tree Loop-guard feature blocking Port: 1 for instance: 1

– The configuration can be verified with the following display command.

```
iS5comm# show spanning-tree
Spanning-tree for VLAN 1
Root Id         Priority   32769
Address    00:01:02:03:04:01
Cost       200000
Port       Gi0/2
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:02:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
```

```
Dynamic Path Cost Lag-Speed Change is Disabled
Name     Role         State        Cost     Prio   Type
----     ----         -----        ----     ----   ------
Gi0/1    Designated   Discarding   200000   128    P2P(*Loop-Inc)
Gi0/2    Root         Forwarding   200000   128    P2P
Spanning-tree for VLAN 2
We are the root of the Spanning Tree
Root Id         Priority   2
Address    00:02:02:03:04:01
Cost       0
Port       0
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 2
Address 00:02:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name     Role         State        Cost     Prio   Type
Gi0/1    Designated   Forwarding   200000   128    P2P
Gi0/2    Designated   Forwarding   200000   128    P2P
Spanning-tree for VLAN 3
Root Id         Priority   32771
Address    00:01:02:03:04:01
Cost       200000
Port       Gi0/1
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32771
Address 00:02:02:03:04:01
Hello Time 2 sec 0 cs, Max Age 20 sec 0 cs, Forward Delay 15 sec 0 cs
Dynamic Path Cost is Disabled
Dynamic Path Cost Lag-Speed Change is Disabled
Name     Role         State        Cost     Prio   Type
Gi0/1    Root         Forwarding   200000   128    P2P
Gi0/2    Alternate    Discarding   200000   128    P2P
```

10.4. Configuring Interop Feature 802.1W

CONTEXT:

Interop feature with *802.1W* can be configured on an interface in *RSTP* mode. Interop feature helps the *802.1D RSTP* port to be compatible with *802.1W*. This is configured on a port which is Point-to-Point link type.

Sample Configuration of Loop Guard on an Interface (in RSTP)

1. Following is a sample configuration for enabling Interop feature (*802.1W*) in *RSTP* in an interface:

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/2
iS5comm(config-if)#no shutdown
iS5comm(config-if)#end
iS5comm# configure terminal
iS5comm(config)# spanning-tree mode rst
Spanning Tree protocol enabled is MST. Now MST is being shutdown and RST
is being enabled
iS5comm(config)# end
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree link-type point-to-point
iS5comm(config-if)# spanning-tree mode dot1w enable
iS5comm(config-if)# end
```

   – Verify the *802.1W* mode using the show command given below.

```
iS5comm# show spanning-tree interface gigabitethernet 0/2 detail
Port 1 [Gi0/1] is Disabled  , Discarding
Port PathCost 200000, Port Priority 128, Port Identifier  128.1
Designated Root has priority 0, address 00:00:00:00:00:00
Designated Bridge has priority 0, address 00:00:00:00:00:00
Designated Port Id is 0.0, Designated PathCost 0
No of Transitions to forwarding State :0
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 0 , received 0
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0,
Error Disable Recovery Interval 300 sec 0 cs
Restricted Role is disabled.
```

```
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled.
Loop Guard is disabled.
Dot1W mode enabled.
```

– In packet capture, verify that the path cost, port ID, Bridge Priority, and Bridge ID *MAC* address are based on the Port priority vector instead of designated priority vector.

```
iS5comm# show spanning-tree
Spanning tree Protocol
Protocol Identifier: Spanning Tree Protocol (0x0000)
Protocol Version Identifier: Rapid Spanning Tree (2)
BPDU Type: Rapid/Multiple Spanning Tree (0x02)
BPDU flags: 0x78 (Agreement, Forwarding, Learning, Port Role: Root)
0... .... = Topology Change Acknowledgment: No
.1.. .... = Agreement: Yes
..1. .... = Forwarding: Yes
...1 .... = Learning: Yes
.... 10.. = Port Role: Root (2)
.... ..0. = Proposal: No
.... ...0 = Topology Change: No
Root Identifier: 32768 / 0 / 00:01:02:03:04:01
Root Bridge Priority: 32768
Root Bridge System ID Extension: 0
Root Bridge System ID: 00:01:02:03:04:01
Root Path Cost: 0
Bridge Identifier: 32768 / 0 / 00:01:02:03:04:01
Bridge Priority: 32768
Bridge System ID Extension: 0
Bridge System ID: 00:01:02:03:04:01

Dot1w Disable:
```

2. Following is a sample configuration for enabling Interop feature (*802.1W*) in *RSTP* in an interface:

FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# spanning-tree mode dot1w disable
iS5comm(config)# end
```

– Verify the *802.1W* mode using the show command given below.

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

```
Port 1 [Gi0/1] is Disabled  , Discarding
Port PathCost 200000, Port Priority 128, Port Identifier  128.1
Designated Root has priority 0, address 00:00:00:00:00:00
Designated Bridge has priority 0, address 00:00:00:00:00:00
Designated Port Id is 0.0, Designated PathCost 0
No of Transitions to forwarding State :0
Auto-Edge is enabled
PortFast is disabled, Oper-Edge is disabled
Link Type is Shared
BPDUs : sent 0 , received 0
Timers: Hello - 0, Forward Delay - 0, Topology Change - 0,
Error Disable Recovery Interval 300 sec 0 cs
Restricted Role is disabled.
Restricted TCN is disabled.
bpdu-transmit enabled
bpdu-receive enabled
Root Guard is disabled.
Loop Guard is disabled.
Dot1W mode disabled.
```

– In packet capture, verify that the path cost, port ID, Bridge Priority, and Bridge ID *MAC* address are based on the designated priority vector.

```
iS5comm# show spanning-tree
Spanning tree Protocol
Protocol Identifier: Spanning Tree Protocol (0x0000)
Protocol Version Identifier: Rapid Spanning Tree (2)
BPDU Type: Rapid/Multiple Spanning Tree (0x02)
BPDU flags: 0x78 (Agreement, Forwarding, Learning, Port Role: Root)
0... .... = Topology Change Acknowledgment: No
.1.. .... = Agreement: Yes
..1. .... = Forwarding: Yes
...1 .... = Learning: Yes
.... 10.. = Port Role: Root (2)
.... ..0. = Proposal: No
.... ...0 = Topology Change: No
Root Identifier: 32768 / 0 / 00:01:02:03:04:01
Root Bridge Priority: 32768
Root Bridge System ID Extension: 0
Root Bridge System ID: 00:01:02:03:04:01
Root Path Cost: 20000
Bridge Identifier: 32768 / 0 / 00:01:02:03:04:01
```

```
Bridge Priority: 32768
Bridge System ID Extension: 0
Bridge System ID: 00:02:02:03:04:01
```