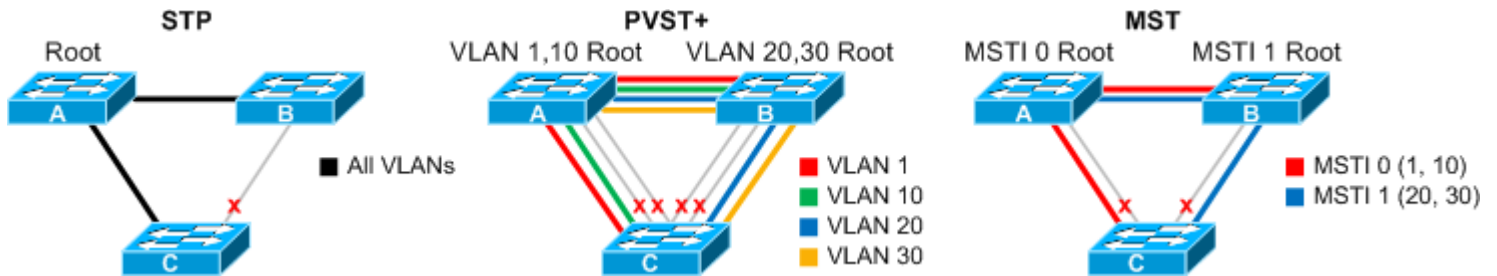


Spanning Tree Protocols

	Legacy STP	PVST	PVST+	RSTP	RPVST+	MST
Algorithm	Legacy ST	Legacy ST	Legacy ST	Rapid ST	Rapid ST	Rapid ST
Definition	802.1D-1998	Cisco	Cisco	802.1w, 802.1D-2004	Cisco	802.1s, 802.1Q-2003
Instances	One	Per VLAN	Per VLAN	One	Per VLAN	Configurable
Trunking	N/A	ISL	802.1Q, ISL	N/A	802.1Q, ISL	802.1Q, ISL

Spanning Tree Instance Comparison



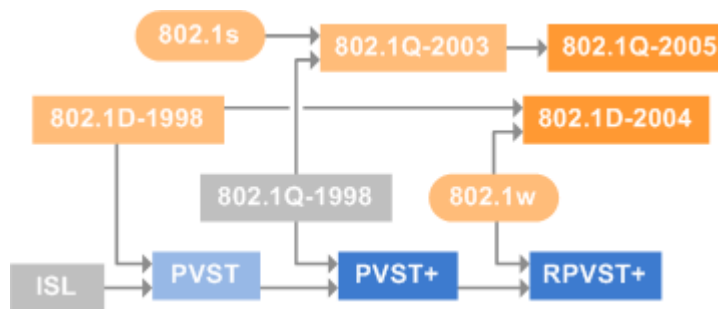
BPDUs Format

Field	Bits
Protocol ID	16
Version	8
BPDUs Type	8
Flags	8
Root ID	64
Root Path Cost	32
Bridge ID	64
Port ID	16
Message Age	16
Max Age	16
Hello Time	16
Forward Delay	16

Default Timers

Hello	2s
Forward Delay	15s
Max Age	20s

Spanning Tree Specifications



Open Standards

IEEE 802.1D-1998 · Deprecated legacy STP standard

IEEE 802.1w · Introduced Rapid STP (RSTP)

IEEE 802.1D-2004 · Replaced legacy STP with RSTP

IEEE 802.1s · Introduced Multiple Spanning Tree (MST)

IEEE 802.1Q-2003 · Added MST to 802.1Q

Cisco Proprietary Implementations

PVST · Per-VLAN implementation of legacy STP

PVST+ · Added 802.1Q trunking to PVST

RPVST+ · Per-VLAN implementation of RSTP

Link Costs

Bandwidth	Cost
4 Mbps	250
10 Mbps	100
16 Mbps	62
45 Mbps	39
100 Mbps	19
155 Mbps	14
622 Mbps	6
1 Gbps	4
10 Gbps	2

Port States

Legacy ST	Rapid ST
Disabled	Discarding
Blocking	Discarding
Listening	Discarding
Learning	Learning
Forwarding	Forwarding

Spanning Tree Operation

- Determine root bridge** · The bridge advertising the lowest bridge ID becomes the root bridge
- Select root port** · Each bridge selects its primary port facing the root
- Select designated ports** · One designated port is selected per segment
- Block ports with loops** · All non-root and non-designated ports are blocked

Port Roles

Legacy ST	Rapid ST
Root	Root
Designated	Designated
Blocking	Alternate
Blocking	Backup

PVST+ and RPVST+ Configuration

```
! Set STP type
spanning-tree mode {pvst | rapid-pvst}

! Bridge priority
spanning-tree vlan 1-4094 priority 32768

! Timers, in seconds
spanning-tree vlan 1-4094 hello-time 2
spanning-tree vlan 1-4094 forward-time 15
spanning-tree vlan 1-4094 max-age 20

! Enabling PortFast by default
spanning-tree portfast default

! PVST+ Enhancements
spanning-tree backbonefast
spanning-tree uplinkfast

! Interface attributes
interface FastEthernet0/1
spanning-tree [vlan 1-4094] port-priority 128
spanning-tree [vlan 1-4094] cost 19

! Manual link type specification
spanning-tree link-type {point-to-point | shared}

! Enables spanning tree if running PVST+, or
! designates an edge port under RPVST+
spanning-tree portfast

! Spanning tree protection
spanning-tree guard {loop | root | none}

! Per-interface toggling
spanning-tree bpduguard enable
spanning-tree bpdufilter enable
```

MST Configuration

```
! Set STP type
spanning-tree mode mst

! MST Configuration
spanning-tree mst configuration
name MyTree
revision 1

! Map VLANs to instances
instance 1 vlan 20, 30
instance 2 vlan 40, 50

! Bridge priority (per instance)
spanning-tree mst 1 priority 32768

! Timers, in seconds
spanning-tree mst hello-time 2
spanning-tree mst forward-time 15
spanning-tree mst max-age 20

! Maximum hops for BPDUs
spanning-tree mst max-hops 20

! Interface attributes
interface FastEthernet0/1
spanning-tree mst 1 port-priority 128
spanning-tree mst 1 cost 19
```

Bridge ID Format



Priority · 4-bit configurable priority (configurable from 0 to 61440 in increments of 4096)

System ID Extension · 12-bit value taken from VLAN number

MAC Address · 48-bit value to ensure uniqueness

Path Selection

- 1 Prefer the neighbor advertising the lowest root ID
- 2 Prefer the neighbor advertising the lowest cost to root
- 3 Prefer the neighbor with the lowest bridge ID
- 4 Prefer the lowest sender port ID

Optional PVST+ Enhancements

PortFast Enables immediate transition into the forwarding state on edge ports

UplinkFast Enables access switches to maintain backup paths to root

BackboneFast Enables immediate expiration of the Max Age timer on an indirect link failure

Spanning Tree Protection

Root Guard Prevents a port from becoming the root port

BPDU Guard Error disables a port if a BPDU is received

Loop Guard Prevents a blocked port from transitioning to listening after the Max Age timer has expired

BPDU Filter Blocks BPDUs on an interface

RSTP Link Types

Point-to-Point Connects to exactly one other bridge (a full duplex interface)

Shared Potentially connects to multiple bridges (a half duplex interface)

Edge Connects to a single host; designated by applying PortFast

Troubleshooting

show spanning-tree [summary | detail]

show spanning-tree root

show spanning-tree vlan <VLAN>

show spanning-tree interface <interface>

show spanning-tree mst [<instance>] [detail]

show spanning-tree mst configuration

show spanning-tree mst interface <interface>