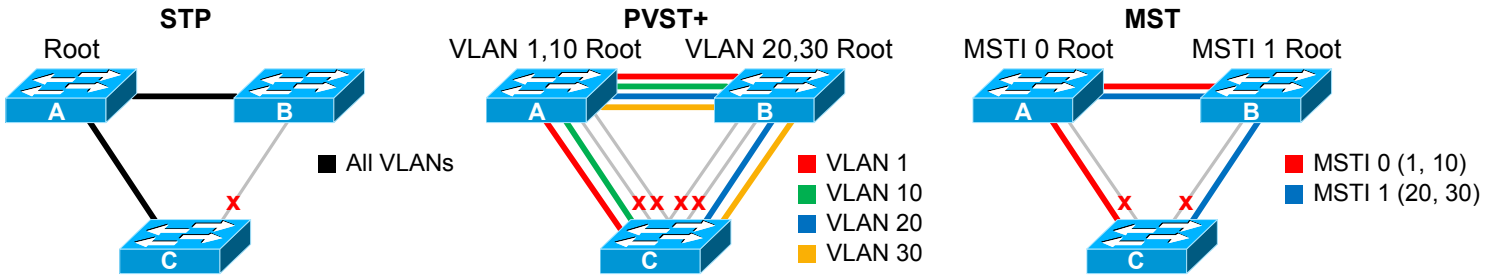


SPANNING TREE · PART 1

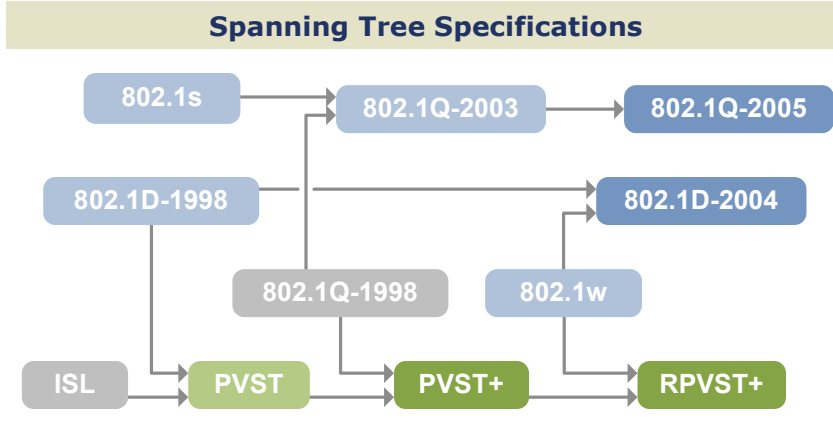
Spanning Tree Protocols

| | Legacy STP | PVST | PVST+ | RSTP | RPVST+ | MST |
|-------------------|-------------|-----------|-------------|------------------------|-------------|------------------------|
| Algorithm | Legacy ST | Legacy ST | Legacy ST | Rapid ST | Rapid ST | Rapid ST |
| Defined By | 802.1D-1998 | Cisco | Cisco | 802.1w, 802.1D-2004 | Cisco | 802.1s, 802.1Q-2003 |
| Instances | 1 | Per VLAN | Per VLAN | 1 | Per VLAN | Configurable |
| Trunking | N/A | ISL | 802.1Q, ISL | N/A | 802.1Q, ISL | 802.1Q, ISL |

Spanning Tree Instance Comparison



| BPDU Format | |
|----------------|------|
| Field | Bits |
| Protocol ID | 16 |
| Version | 8 |
| BPDU 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 |



| 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 |
| 20+ Gbps | 1 |

| | |
|-------|--|
| IEEE | IEEE 802.1D-1998 · Deprecated legacy STP standard |
| | IEEE 802.1w · Introduced RSTP |
| | IEEE 802.1D-2004 · Replaced legacy STP with RSTP |
| | IEEE 802.1s · Introduced MST |
| | IEEE 802.1Q-2003 · Added MST to 802.1Q |
| Cisco | IEEE 802.1Q-2005 · Most recent 802.1Q revision |
| | PVST · Per-VLAN implementation of legacy STP |
| | PVST+ · Added 802.1Q trunking to PVST |
| | RPVST+ · Per-VLAN implementation of RSTP |

| Default Timers | |
|----------------|-----|
| Hello | 2s |
| Forward Delay | 15s |
| Max Age | 20s |

| Port States | |
|-------------|------------|
| Legacy ST | Rapid ST |
| Disabled | Discarding |
| Blocking | Listening |
| Listening | Learning |
| Learning | Forwarding |
| 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 Backup |

PVST+ and RPVST+ Configuration

```
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

! 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 PortFast 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

```
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

| 4 | 12 | 48 |
|-----|------------|-------------|
| Pri | Sys ID Ext | MAC Address |

Priority

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

System ID Extension

12-bit value taken from VLAN number (IEEE 802.1t)

MAC Address

48-bit unique identifier

Path Selection

- 1 Bridge with lowest root ID becomes the root
- 2 Prefer the neighbor with 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 (designates edge ports under MST)

UplinkFast

Enables switches to maintain backup paths to root

BackboneFast

Enables immediate expiration of the Max Age timer in the event of 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 (disables STP)

RSTP Link Types

Point-to-Point

Connects to exactly one other bridge (full duplex)

Shared

Potentially connects to multiple bridges (half duplex)

Edge

Connects to a single host; designated by PortFast

Troubleshooting

```
show spanning-tree [summary | detail | root]
show spanning-tree [interface | vlan]
show spanning-tree mst [...]
```