802.1D and PVST+

- 802.1D and PVST+ use the same timer based mechanisms to build loop free paths and converge when there is a topology change
  - 802.1D uses a single STP instance for all VLANs, PVST+ uses separate instances per VLAN
  - PVST+ supports proprietary Cisco features such as PortFast, UplinkFast, BackboneFast, (they bypass timers to improve convergence) Root Guard and Loop Guard (protection mechanisms)

RSTP, RPVST+ and MSTP

- RSTP, RPVST+ and MSTP use the same mechanisms to build loop free paths and converge when there is a topology change
  - RSTP uses a single STP instance for all VLANs
  - RPVST+ uses separate instances per VLAN
  - MSTP groups multiple VLANs into spanning tree instances

RSTP, RPVST+ and MSTP (Cont.)

- RSTP, RPVST+ and MSTP have equivalent convergence toUplinkFast and BackboneFast built-in, the features do not need to be enabled
- RPVST+ supports protection features Root Guard and Loop Guard
- RSTP/MSTP Edge Port feature corresponds with PortFast in RPVST+

802.1D and PVST+ Port States

Timers are used to transition ports to the Forwarding state:

- (**Disabled:** Port is down)
- (**Blocking:** If there has been a link failure in the topology and a port has to failed over to forwarding, it can remain in a blocking state for up to the Max Age timer of 20 seconds by default)
- **Listening:** Transitional state. Can send and receive BPDUs. Does not forward traffic, does not learn MAC addresses. Forward Delay timer 15 seconds by default.
- **Learning:** Transitional state. Can learn MAC addresses, does not forward traffic. Forward Delay timer 15 seconds by default.
- **Forwarding:** Forwards traffic. Occurs after 30 seconds (Listening and Learning time) by default. Portfast skips Listening and Learning states.

802.1D and PVST+ Convergence

- 802.1D and PVST+ share the same timer based convergence mechanism. A port coming online takes 30 seconds to become forwarding by default, and the network can take up to 50 seconds to converge following a link failure
- This delay is often not acceptable in modern networks

RSTP Proposal/Agreement Handshake

- Rather than waiting on the BPDU Forward Delay and potentially Max Age timers for convergence as 802.1D does, RSTP uses a proactive Proposal/Agreement 'Sync' mechanism to rapidly build the Spanning Tree and respond to topology changes
- Switches actively negotiate directly with each other that ports can safely transition to the forwarding state, without the need for timers
- Rapid convergence (typically within a few seconds) is achieved across the STP topology

Cisco Supported Versions

- Most modern Cisco switches support PVST+, RPVST+, and MSTP.
- PVST+ is the default on most Cisco switches.

Spanning Tree Version Configuration

```
CD1(config)#spanning-tree mode ?
  mst          Multiple spanning tree mode
  pvst         Per-Vlan spanning tree mode
  rapid-pvst   Per-Vlan rapid spanning tree mode

CD1#show spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: none
Extended system ID is enabled
! truncated
```

Version Interoperability – New/Old Versions

- Newer Spanning Tree versions are backwards compatible with older versions
- Newer versions detect older versions based on the Protocol Version ID and BPDU Type fields in the received BPDUs
- STP falls back to the older version on ports connected to switches running the older version
- The newer version enhancements are not available on those ports