Chapter 4
Spanning Tree Protocol (STP)

This chapter describes advanced Layer 2 features that enable you to overcome limitations in the standard 802.1d Spanning Tree Protocol (STP). This chapter describes the following features:

- Fast Port Span
- Fast Uplink Span
- Single-instance STP

These enhancements extend the operation of standard STP, allowing you to fine tune standard STP and avoid some of its limitations.

Fast Port Span

When STP is running on a device, message forwarding is delayed during the spanning tree recalculation period following a topology change. The STP forward delay parameter specifies the period of time a bridge waits before forwarding data packets. The forward delay controls the listening and learning periods of STP reconvergence. You can configure the forward delay to a value from 4 – 30 seconds. The default is 15 seconds. Thus, using the standard forward delay, convergence requires 30 seconds (15 seconds for listening and an additional 15 seconds for learning) when the default value is used.

This slow convergence is undesirable and unnecessary in some circumstances. The Fast Port Span feature allows certain ports to enter the forwarding state in four seconds. Specifically, Fast Port Span allows faster convergence on ports that are attached to end stations and thus do not present the potential to cause Layer 2 forwarding loops. Because the end stations cannot cause forwarding loops, they can safely go through the STP state changes (blocking to listening to learning to forwarding) more quickly than is allowed by the standard STP convergence time. Fast Port Span performs the convergence on these ports in four seconds (two seconds for listening and two seconds for learning).

In addition, Fast Port Span enhances overall network performance in the following ways:

- Fast Port Span reduces the number of STP topology change notifications on the network. When an end station attached to a Fast Span port comes up or down, the HP device does not generate a topology change notification for the port. In this situation, the notification is unnecessary since a change in the state of the host does not affect the network’s topology.
- Fast Port Span eliminates unnecessary MAC cache aging that can be caused by topology change notifications. Bridging devices age out the learned MAC addresses in their MAC caches if the addresses are unrefreshed for a given period of time, sometimes called the MAC aging interval. When STP sends a topology change notification, devices that receive the notification use the value of the STP forward delay to quickly age out their MAC caches. For example, if a device’s normal MAC aging interval is 5 minutes, the aging interval changes temporarily to the value of the forward delay (for example, 15 seconds) in response to an STP topology change.
In normal STP, the accelerated cache aging occurs even when a single host goes up or down. Because Fast Port Span does not send a topology change notification when a host on a Fast Port Span port goes up or down, the unnecessary cache aging that can occur in these circumstances under normal STP is eliminated.

Fast Port Span is a system-wide parameter and is enabled by default. Thus, when you boot a device with software release 06.x or later, all the ports that are attached only to end stations run Fast Port Span. For ports that are not eligible for Fast Port Span, such as ports connected to other networking devices, the device automatically uses the normal STP settings. If a port matches any of the following criteria, the port is ineligible for Fast Port Span and uses normal STP instead:

- The port is 802.1q tagged
- The port is a member of a trunk group
- The port has learned more than one active MAC address
- An STP Configuration BPDU has been received on the port, thus indicating the presence of another bridge on the port.

You can also explicitly exclude individual ports from Fast Port Span if needed. For example, if the only uplink ports for a wiring closet switch are Gigabit ports, you can exclude the ports from Fast Port Span.

### Disabling and Re-enabling Fast Port Span

Fast Port Span is a system-wide parameter and is enabled by default. Thus all ports that are eligible for Fast Port Span use it.

To disable or re-enable Fast Port Span, use one of the following methods.

**USING THE CLI**

To disable Fast Port Span, enter the following commands:

```bash
HP9300(config)# no fast port-span
HP9300(config)# write memory
```

**Syntax:** `[no] fast port-span`

**NOTE:** The `fast port-span` command has additional parameters that let you exclude specific ports. These parameters are shown in the following section.

To re-enable Fast Port Span, enter the following commands:

```bash
HP9300(config)# fast port-span
HP9300(config)# write memory
```

**USING THE WEB MANAGEMENT INTERFACE**

1. Log on to the device using a valid user name and password for read-write access.
2. Click the Fast checkbox next to Spanning Tree to remove the checkmark from the box.
3. Click Apply to apply the change to the device's running-config file.
4. Select the **Save** link at the bottom of the panel. Select Yes when prompted to save the configuration change to the startup-config file on the device's flash memory.
Excluding Specific Ports from Fast Port Span

You can exclude individual ports from Fast Port Span while leaving Fast Port Span enabled globally. To do so, use one of the following methods.

**USING THE CLI**

To exclude a port from Fast Port Span, enter commands such as the following:

```
HP9300(config)# fast port-span exclude ethernet 1/1
HP9300(config)# write memory
```

To exclude a set of ports from Fast Port Span, enter commands such as the following:

```
HP9300(config)# fast port-span exclude ethernet 1/1 ethernet 2/1 ethernet 3/2
HP9300(config)# write memory
```

To exclude a contiguous (unbroken) range of ports from Fast Span, enter commands such as the following:

```
HP9300(config)# fast port-span exclude ethernet 1/1 to 1/24
HP9300(config)# write memory
```

**Syntax:** `[no] fast port-span [exclude ethernet <portnum> [ethernet <portnum>… | to <portnum>] ]

To re-enable Fast Port Span on a port, enter a command such as the following:

```
HP9300(config)# no fast port-span exclude ethernet 1/1
HP9300(config)# write memory
```

This command re-enables Fast Port Span on port 1/1 only and does not re-enable Fast Port Span on other excluded ports. You also can re-enable Fast Port Span on a list or range of ports using the syntax shown above this example.

To re-enable Fast Port Span on all excluded ports, disable and then re-enable Fast Port Span by entering the following commands:

```
HP9300(config)# no fast port-span
HP9300(config)# fast port-span
HP9300(config)# write memory
```

Disabling and then re-enabling Fast Port Span clears the exclude settings and thus enables Fast Port Span on all eligible ports. To make sure Fast Port Span remains enabled on the ports following a system reset, save the configuration changes to the startup-config file after you re-enable Fast Port Span. Otherwise, when the system resets, those ports will again be excluded from Fast Port Span.

**USING THE WEB MANAGEMENT INTERFACE**

You cannot exclude individual ports from Fast Span using the Web management interface.

Fast Uplink Span

The Fast Port Span feature described in the previous section enhances STP performance for end stations. The Fast Uplink feature enhances STP performance for wiring closet switches with redundant uplinks. Using the default value for the standard STP forward delay, convergence following a transition from an active link to a redundant link can take 30 seconds (15 seconds for listening and an additional 15 seconds for learning).

You can use the Fast Uplink feature on an HP device deployed as a wiring closet switch to decrease the convergence time for the uplink ports to another device to just four seconds (two seconds for listening and two seconds for learning). The wiring closet switch must be an HP device but the device at the other end of the link can be an HP device or another vendor's switch. Configuration of the Fast Uplink Span feature takes place entirely on the HP device.

To configure the Fast Uplink Span feature, you specify a group of ports that have redundant uplinks on the wiring closet switch (HP device) as members of a Fast Uplink Group. If the active link becomes unavailable, the Fast Uplink Span feature transitions the forwarding to one of the other ports in four seconds. You can configure one Fast Uplink Span group on the device. All Fast Uplink Span ports are members of the same Fast Uplink Span group.
NOTE: To avoid the potential for temporary bridging loops, HP recommends that you use the Fast Uplink feature only for wiring closet switches (switches at the edge of the network cloud). In addition, enable the feature only on a group of ports intended for redundancy, so that at any given time only one of the ports is expected to be in the forwarding state.

NOTE: When the wiring closet switch (HP device) first comes up or when STP is first enabled, the uplink ports still must go through the standard STP state transition without any acceleration. This behavior guards against temporary routing loops as the switch tries to determine the states for all the ports. Fast Uplink Span acceleration applies only when a working uplink becomes unavailable.

Fast Uplink Span Rules for Trunk Groups
If you add a port to a Fast Uplink Span group that is a member of a trunk group, the following rules apply:

- If you add the primary port of a trunk group to the Fast Uplink Span group, all other ports in the trunk group are automatically included in the group. Similarly, if you remove the primary port in a trunk group from the Fast Uplink Span group, the other ports in the trunk group are automatically removed from the Fast Uplink Span group.

- You cannot add a subset of the ports in a trunk group to the Fast Uplink Span group. All ports in a trunk group have the same Fast Uplink Span property, as they do for other port properties.

- If the working trunk group is partially down but not completely down, no switch-over to the backup occurs. This behavior is the same as in the standard STP feature.

- If the working trunk group is completely down, a backup trunk group can go through an accelerated transition only if the following are true:
  - The trunk group is included in the fast uplink group.
  - All other ports except those in this trunk group are either disabled or blocked. The accelerated transition applies to all ports in this trunk group.

- When the original working trunk group comes back (partially or fully), the transition back to the original topology is accelerated if the conditions listed above are met.

Configuring a Fast Uplink Port Group
To enable Fast Uplink, use one of the following methods.

USING THE CLI
To configure a group of ports for Fast Uplink Span, enter the following commands:

HP9300(config)# fast uplink-span ethernet 4/1 to 4/4
HP9300(config)# write memory

Syntax: [no] fast uplink-span [ethernet <portnum> [ethernet <portnum>… | to <portnum>]]

This example configures four ports, 4/1 – 4/4, as a Fast Uplink Span group. In this example, all four ports are connected to a wiring closet switch. Only one of the links is expected to be active at any time. The other links are redundant. For example, if the link on port 4/1 is the active link on the wiring closet switch but becomes unavailable, one of the other links takes over. Because the ports are configured in a Fast Uplink Span group, the STP convergence takes about four seconds instead of taking 30 seconds or longer using the standard STP forward delay.

If you add a port that is the primary port of a trunk group, all ports in the trunk group become members of the Fast Uplink Span group.

You can add ports to a Fast Uplink Span group by entering the fast uplink-span additional times with additional ports. The device can have only one Fast Uplink Span group, so all the ports you identify as Fast Uplink Span ports are members of the same group.
To remove a Fast Uplink Span group or to remove individual ports from a group, use “no” in front of the appropriate fast uplink-span command. For example, to remove ports 4/3 and 4/4 from the Fast Uplink Span group configured above, enter the following commands:

HP9300(config)# no fast uplink-span ethernet 4/3 to 4/4
HP9300(config)# write memory

If you delete a port that is the primary port of a trunk group, all ports in the trunk group are removed from the Fast Uplink Span group.

**USING THE WEB MANAGEMENT INTERFACE**

You cannot configure the Fast Uplink Span feature using the Web management interface.

### Single Spanning Tree

In software releases earlier than 05.2.16, each port-based VLAN runs a separate spanning tree, which you can enable or disable on an individual VLAN basis. This is still the default behavior in software release 06.x and later. However, this software release enhances HP’s STP support by enabling you to configure a single instance of the Spanning Tree Protocol (STP) to run on all the port-based VLANs on a device.

The single STP feature is especially useful for connecting an HP device to other devices that run a single spanning tree in accordance with the 802.1q specification.

Single-instance STP uses the same parameters, with the same value ranges and defaults, as the default STP on HP devices (multiple-instance STP).

### STP Defaults

STP is enabled by default on switches and disabled by default on routing switches. On switches and routing switches, each port-based VLAN runs a separate instance of STP by default. Thus, on devices that have multiple port-based VLANs, each VLAN has its own spanning tree domain. In addition, the STP state of each port-based VLAN is independent of the STP states of other VLANs. You can have STP enabled on port-based VLAN 10, but disabled on port-based VLANs 20 and 30, and so on.

When you configure a port-based VLAN, that VLAN inherits the STP state of the default port-based VLAN. Thus, if STP is enabled on the default VLAN, STP is also enabled on the new port-based VLAN. You can change the STP state of the VLAN afterwards. Changes to the STP state of the default VLAN do not affect existing VLANs. A change to the STP state affects only the VLANs you create after the change.

### Single STP and Existing Port-Based VLANs

When you enable single STP, all the ports on the device become members of a single spanning tree domain. Thus, the ports share a single BPDU broadcast domain. The HP device places all the ports in a non-configurable VLAN, 4094, to implement the single STP domain. However, this VLAN does not affect port membership in the port-based VLANs you have configured. Other broadcast traffic is still contained within the individual port-based VLANs. Therefore, you can use single STP while still using your existing VLAN configurations without changing your network. In addition, single STP does not affect 802.1q tagging. Tagged and untagged ports alike can be members of the single spanning tree domain.

**NOTE:** When single STP is enabled, the BPDUs on tagged ports go out untagged.

**NOTE:** If STP is disabled on a VLAN, you must enable STP on the VLAN before enabling single STP.
Spanning Tree Parameters

The STP parameters behave the same and have the same defaults and possible values whether you use single STP or you use the default configuration of a separate spanning tree for each port-based VLAN (multiple-instance STP).

You can configure the following parameters on the global level. The parameters apply to all ports.

- **Forward Delay** – The period of time a bridge will wait (the listen and learn period) before forwarding data packets. Possible values: 4 – 30 seconds. Default is 15.

- **Maximum Age** – The interval a bridge will wait for receipt of a hello packet before initiating a topology change. Possible values: 6 – 40 seconds. Default is 20.

- **Hello Time** – The interval of time between each configuration BPDU sent by the root bridge. Possible values: 1 – 10 seconds. Default is 2.

- **Priority** – A parameter used to identify the root bridge in a network. The bridge with the lowest value has the highest priority and is the root. Possible values: 0 – 65,535. Default is 32,678.

You can apply the following parameters on an individual port level.

- **Port Priority** – This parameter can be used to assign a higher (or lower) priority to a port. In the event that traffic is re-routed, this parameter gives the port forwarding preference over lower priority ports within a VLAN or on the switch or routing switch (when no VLANs are configured for the system). Ports are re-routed based on their priority. The highest value is routed first. Possible values: 0 – 255. Default is 128. This value overrides the system-wide STP priority.

- **Path Cost** – This parameter can be used to assign a higher or lower path cost to a port. This value can be used to bias traffic toward or away from a certain path during periods of rerouting. For example, if you wish to bias traffic away from a certain port, assign it a higher value than other ports within the VLAN or all other ports (when VLANs are not active on the switch or routing switch). Possible values are 0 – 65,535 and the default values are 1000/port speed for half-duplex ports and (1000/port speed)/2 for full-duplex ports.

Enabling Single STP

To enable single STP, use one of the following methods.

**NOTE:** If the device has only one port-based VLAN (the default VLAN), then the device is already running a single instance of STP. In this case, you do not need to enable single STP. You need to enable single STP only if the device contains more than one port-based VLAN and you want all the ports to be in the same STP broadcast domain.

**NOTE:** If STP is disabled on a VLAN, you must enable STP on the VLAN before enabling single STP.

**USING THE CLI**

To configure the HP device to run a single spanning tree, enter the following command at the global CONFIG level.

```
HP9300(config) spanning-tree single
```

Here is the syntax for the global STP parameters.

**Syntax:** [no] spanning-tree single [forward-delay <value>] [hello-time <value>] | [maximum-age <time>] | [priority <value>]

Here is the syntax for the STP port parameters.

**Syntax:** [no] spanning-tree single [ethernet <portnum> path-cost <value> | priority <value>]

**NOTE:** Both commands listed above are entered at the global CONFIG level.
NOTE: If the device has only one port-based VLAN, the CLI command for enabling single-instance STP is not listed in the CLI. The command is listed only if you have configured a port-based VLAN.

To change a global STP parameter, enter a command such as the following at the global CONFIG level:

```
HP9300(config) spanning-tree single priority 2
```

This command changes the STP priority for all ports to 2.

To change an STP parameter for a specific port, enter commands such as the following:

```
HP9300(config) spanning-tree single ethernet 1/1 priority 10
```

The commands shown above override the global setting for the STP priority and set the priority to 10 for port 1/1.

To verify that single STP is in effect, enter the following command at any level of the CLI:

```
HP9300(config) show span
```

**Syntax:** show span [vlan <vlan-id>]

Here is an example of the information displayed by this command. Notice that no VLAN IDs are listed in the VLAN ID column. For STP, all ports are members of VLAN 4094, the single STP VLAN. When you enable single STP, all the ports in the single spanning tree, regardless of other VLAN membership, are configured as members of port-based VLAN 4094. This VLAN is used to implement the single spanning tree. VLAN 4094 is used only by single spanning tree. A port can be a member of VLAN 4094 and another port-based VLAN at the same time without being tagged. All ports in VLAN 4094 share a common STP domain, but for all other traffic, the ports remain within the separate Layer 2 broadcast domains established by the port-based VLANs.

```
HP9300(config)# show span
Global STP Parameters:
VLAN Root             Root Root Prio Max He- Ho- Fwd Last     Chg  Bridge
ID   ID              Cost Port rity Age llo ld  dly Chang cnt  Address
Hex  sec sec sec sec sec
800000e052f04f00 0    Root 8000 20  2   2   15  0        0    00e052f04f00

Port STP Parameters:
VLAN Port Prio Path State      Fwd    Design Design           Design
ID  Num  rity Cost            Trans  Cost   Root             Bridge
Hex
1/1  80   0    DISABLED   0      0      0000000000000000 0000000000000000
1/2  80   0    DISABLED   0      0      0000000000000000 0000000000000000
1/3  80   0    DISABLED   0      0      0000000000000000 0000000000000000
1/4  80   0    DISABLED   0      0      0000000000000000 0000000000000000
```

To display VLAN information, including the STP state of each VLAN, enter the following command at any CLI level:

```
HP9300(config)# show vlan
```

**Syntax:** show vlan [vlan <vlan-id> | ethernet <portnum>]

```
HP9300(config)# show vlan
```

```
Total PORT-VLAN entries: 3
Maximum PORT-VLAN entries: 8
legend: [S=Slot]
PORT-VLAN 1, Name DEFAULT-VLAN, Priority level0, in single spanning tree domain
```

... some lines omitted for brevity ...

...
Untagged Ports: (S1)  1  2  3  4  5  6  7  8
Untagged Ports: (S2)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S2)  17 18 19 20 21 22 23 24
Untagged Ports: (S4)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S4)  17 18 19 20 21 22 23 24
Untagged Ports: (S6)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S6)  17 18 19 20 21 22 23 24

Tagged Ports: None

SINGLE-SPANNING-TREE-VLAN, Name Single-spanning-tree-vlan, Priority level0, in single spanning tree domain
Untagged Ports: (S1)  1  2  3  4  5  6  7  8
Untagged Ports: (S2)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S2)  17 18 19 20 21 22 23 24
Untagged Ports: (S4)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S4)  17 18 19 20 21 22 23 24
Untagged Ports: (S6)  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Untagged Ports: (S6)  17 18 19 20 21 22 23 24

Tagged Ports: None

This example shows information for port-based VLAN 1, which is the default VLAN. Notice that a message indicates that the VLAN is in the single STP domain. Also notice that the SINGLE-SPANNING-TREE-VLAN contains all the ports in the device.

**USING THE WEB MANAGEMENT INTERFACE**

1. Log on to the device using a valid user name and password for read-write access. The System configuration dialog is displayed.
2. Click on the Single checkbox next to Spanning Tree to place a checkmark in the box.
3. Click Apply to apply the change to the device’s running-config file.
4. Select the Save link at the bottom of the panel. Select Yes when prompted to save the configuration change to the startup-config file on the device’s flash memory.