

Spanning Tree Interoperability

This Application Note relates to the following Dell PowerConnect™ products:

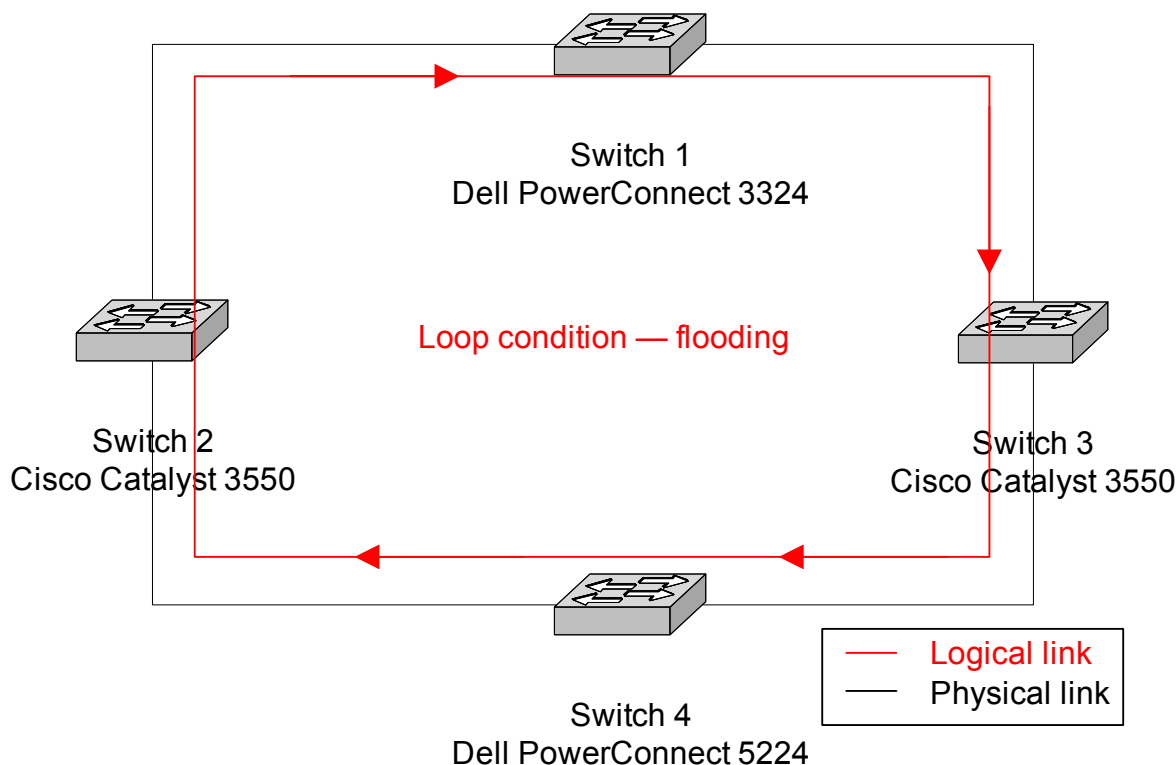
- PowerConnect 33xx
- PowerConnect 52xx

Abstract

As bridged networks grow, the challenge of keeping switching paths loop-free and fully converged becomes more difficult. The spanning tree protocol (STP) enables loop-free, redundant bridging paths by controlling the forwarding state of links between switches. Wherever two paths to a given destination exist, spanning tree eliminates the possibility of a loop by forwarding on only one of the paths, and “failing over” to the other path in the event of a link or interface failure. This application note explores the value of STP and rapid STP (RSTP) in bridged Ethernet networks, and provides step-by-step examples for setting up spanning tree between Dell PowerConnect and Cisco Catalyst® switches.

Applicable Network Scenarios

The following diagram depicts a typical switched topology in an enterprise setting with spanning tree disabled.



In this instance, a Dell PowerConnect 3324 and PowerConnect 5224 (switches 1 and 4) have one uplink to each of two Cisco Catalyst 3550s (switches 2 and 3).

Without STP, all switches “flood” any frames they receive with an unknown destination media access control (MAC) address. The switches will forward the frame to all interfaces, introducing duplicate frames and leading to a “loop” in which all switches continually forward all frames. This is not only inefficient but

also extremely taxing on network resources. Besides violating IEEE protocols, duplicate frames can create “broadcast storms” that pose a threat to network and application stability.

With STP and RSTP, only one uplink at a time is active, stopping floods and enabling reconvergence upon failure of a link or interface.

Technology Background

Spanning tree, described in the IEEE standard 802.1D, is the mechanism switches and bridges use to establish and maintain a single, loop-free bridging path. STP-enabled bridges and switches send out BPDUs (bridge protocol data units) on all interswitch links, and then elect a “root bridge” based on priority (hence the term “spanning tree”). If priorities are the same across all switches, the switches elect the device with the lowest MAC address as the root bridge.

After electing a root bridge, the switches use the spanning tree algorithm (STA) to calculate loop-free paths across the entire switched network. Switches set ports with the lowest-cost path to the root bridge into a “forwarding” state, and other interswitch ports into a “blocking” state. In the event of a link or interface failure, the STA recalculates the bridging path. Each switch will place ports that were previously in blocking state into forwarding state where necessary, thus providing redundancy and reconvergence.

One undesirable characteristic of the original 802.1D standard is the lengthy amounts of time – often 30 seconds or longer – needed for reconvergence after fault discovery. These long delays are built into the 802.1D specification through its use of timers.

Rapid spanning tree, described in IEEE standard 802.1w, speeds reconvergence through use of a real-time handshake mechanism rather than timers. Instead of waiting for a timer to expire, agreements sent in response to previously transmitted proposals trigger changes in port state. Handshakes propagate throughout the network until the bridges reach complete convergence. With RSTP, reconvergence of Dell PowerConnect switches occurs within 3 seconds, even in [large networks.

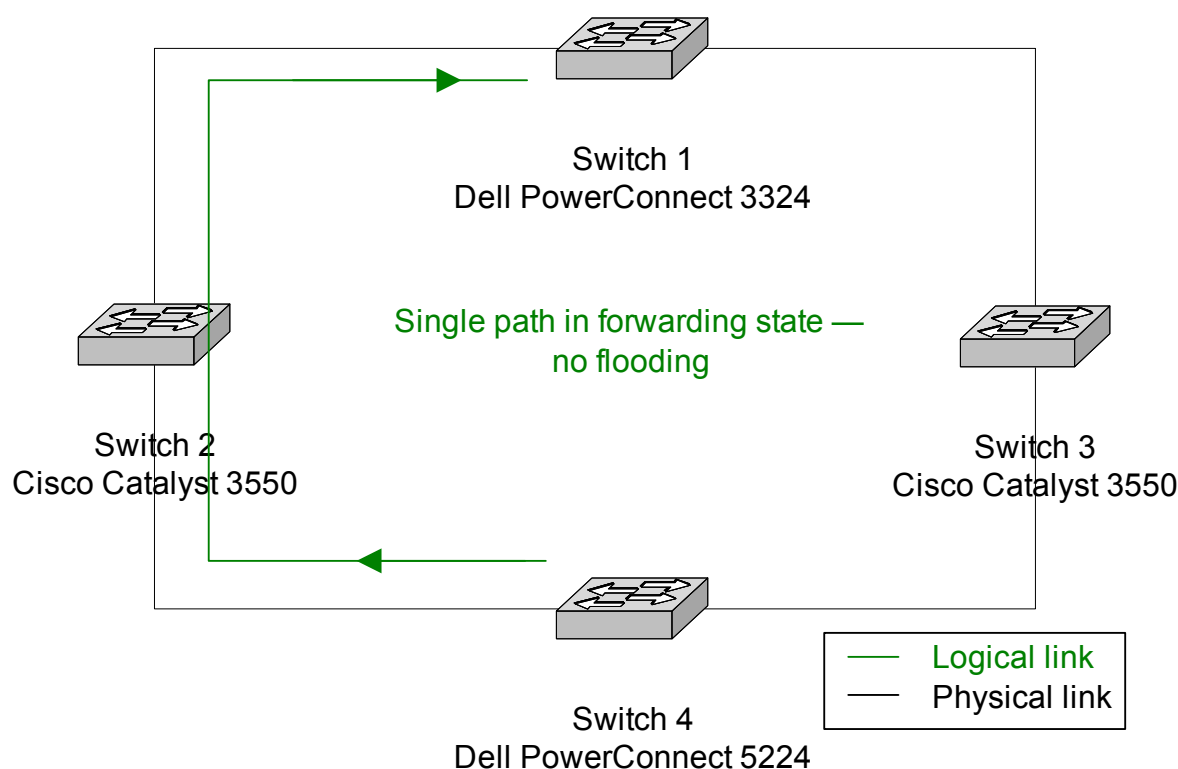
Proposed Solution

STP is needed to ensure loop-free, redundant switched networks. Dell PowerConnect switches have STP enabled by default. However, for most efficient integration of PowerConnect switches into existing Cisco networks, RSTP mode will allow much faster network convergence. Take the following steps to set up STP with minimal convergence time:

- Force speed and duplex settings on all switch uplink ports
- Enable STP with RSTP mode on all Dell PowerConnect switches
- Enable STP on all Cisco devices (this is the default)

Note: Cisco Catalyst 3550s (and most other midrange Cisco switches) have Cisco’s proprietary Per-VLAN Spanning Tree Protocol (PVST+) enabled by default. However, Cisco switches will revert to using 802.1D STP with a peer switch after receiving a BPDU.

With STP enabled, switches will select a root bridge and place redundant links in a blocked state. The following diagram depicts switch behavior with STP enabled. With spanning tree, traffic cannot loop because only one path is in forwarding state.



It's possible to scale up this design to include more distribution and access switches as needed. With STP enabled on all four switches in the diagram, other switches in the campus network will take them into consideration when calculating the logical bridging path.

Step-By-Step Instructions

The following scenario integrates Dell PowerConnect switches into a network of Cisco Catalyst 3550 switches. Although the Cisco switches in this example use Cisco IOS Version 12.1(13)EA1, the same commands should work across any Cisco Catalyst switches running IOS.

1. Force all switch uplink ports to 100-Mbit/s, full-duplex operation. This eliminates any possible issues with autonegotiation and ensures BPDUs will propagate correctly.

Switch 1 (PowerConnect 3324):

```
Switch1 (config)# interface ethernet 1/e1
Switch1 (config-if)#
Switch1 (config-if)# no shutdown
Switch1 (config-if)# duplex full
Switch1 (config-if)# speed 100
Switch1 (config-if)# exit
Switch1 (config)# interface ethernet 1/e2
Switch1 (config-if)#
Switch1 (config-if)# no shutdown
Switch1 (config-if)# duplex full
Switch1 (config-if)# speed 100
Switch1 (config-if)# exit
```

Switch 4 (PowerConnect 5524):

```
Switch4 (config)# interface ethernet 1/1
Switch4 (config-if)#
Switch4 (config-if)# no shutdown
Switch4 (config-if)# speed-duplex 100full
Switch4 (config-if)# exit
Switch4 (config)# interface ethernet 1/2
Switch4 (config-if)#
Switch4 (config-if)# no shutdown
Switch4 (config-if)# speed-duplex 100full
Switch4 (config-if)# exit
```

Switch 2 (Catalyst 3550):

```
Switch2(config)# int fa0/1
Switch2(config-if)# no shutdown
Switch2(config-if)# duplex full
Switch2(config-if)# speed 100
Switch2(config-if)# exit
Switch2(config)# int fa0/2
Switch2(config-if)# no shutdown
Switch2(config-if)# duplex full
Switch2(config-if)# speed 100
Switch2(config-if)# exit
```

Switch 3 (Catalyst 3550):

```
Switch2(config)# int fa0/1
Switch2(config-if)# no shutdown
Switch2(config-if)# duplex full
Switch2(config-if)# speed 100
Switch2(config-if)# exit
Switch2(config)# int fa0/2
Switch2(config-if)# no shutdown
Switch2(config-if)# duplex full
Switch2(config-if)# speed 100
Switch2(config-if)# exit
```

2. Enable STP with RSTP mode**Switch 1 (PowerConnect 3324):**

```
Switch1 (config)# spanning-tree
Switch1 (config)# spanning-tree mode rstp
Switch1 (config)# spanning-tree forward-time 15
Switch1 (config)# spanning-tree hello-time 2
Switch1 (config)# spanning-tree max-age 20
```

Switch 4 (PowerConnect 5524):

```
Switch4 (config)# spanning-tree
Switch4 (config)# spanning-tree mode rstp
Switch4 (config)# spanning-tree forward-time 15
Switch4 (config)# spanning-tree hello-time 2
Switch4 (config)# spanning-tree max-age 20
```

3. Verify STP is operational.

Switch 1 and 4:

```
Switch1 console# show span
```

```
Spanning tree enabled mode RSTP
```

```

Root ID      Priority      32768
             Address      00:0b:db:f5:90:5d
             Cost        0
             Port        0
             Hello Time  2 sec   Max Age 20 sec   Forward Delay 15 sec
Bridge ID    Priority      32768
             Address      00:0b:db:f5:90:5d
             Hello Time  2 sec   Max Age 20 sec   Forward Delay 15 sec
Number of topology changes 9 last change occurred 00:00:22 ago
Times: hold 1, topology change 35, notification 2
        hello 2, max age 20, forward delay 15

```

Interface Port ID				Designated				Port ID	
Name	Prio	Sts	Enb	Cost	Cost	Bridge Id		Prio	Nbr
1/e1	128	FRW	TRUE	19	0	8000	00:0b:db:f5:90:5d	80	01
1/e2	128	BLK	TRUE	100	0	8000	00:0b:db:f5:90:5d	80	02
1/e3	128	DSBL	TRUE	19	0	8000	00:0b:db:f5:90:5d	80	03
1/e4	128	DSBL	TRUE	100	0	8000	00:0b:db:f5:90:5d	80	04
1/e5	128	DSBL	TRUE	100	0	8000	00:0b:db:f5:90:5d	80	05
1/e6	128	DSBL	TRUE	100	0	8000	00:0b:db:f5:90:5d	80	06
1/e7	128	DSBL	TRUE	100	0	8000	00:0b:db:f5:90:5d	80	07

This example is from a Dell PowerConnect 3324 switch; the output is similar for PowerConnect 52xx switches.

Conclusion

In this example, switches 1 and 4 have put interface 1/e1 into a forwarding state and interface 1/e2 into a blocked state. STP is operating properly, as it has elected Switch 2 to be the root bridge and has prevented a loop by blocking the redundant link to Switch 3.

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