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Network Revolution in the IT Industry: Transforming Connectivity and Innovation

Pradip Suresh Patole

Blackbox Network Services, USA

I. SPANNING TREE PROTOCOL (STP) OVERVIEW

Spanning Tree Protocol (STP) is a Layer 2 protocol essential in Ethernet networks to prevent network loops. Redundant paths in a network can cause:

- 1) Broadcast storms: Excessive traffic that floods the network.
- 2) Multiple frame copies: Duplication of frames, creating confusion.
- 3) MAC table instability: Incorrect MAC address mapping due to looped traffic.

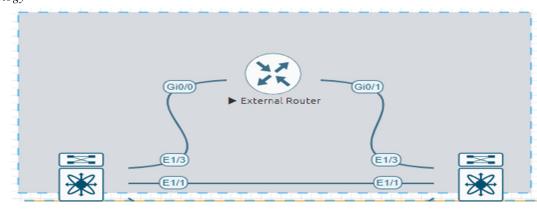
STP ensures there is always a single active path between devices in a network by blocking redundant paths until needed.

II. KEY FEATURES OF TRADITIONAL STP

- 1) IEEE Standard: Defined by the IEEE 802.1D specification.
- 2) Root Bridge Election: Utilizes Bridge Protocol Data Units (BPDUs) to elect a Root Bridge, which acts as the central reference point in the network topology.
- 3) Port States:
- Blocking: Prevents loops by not forwarding frames.
- Listening: Monitors BPDUs but doesn't forward traffic.
- Learning: Builds MAC address tables without forwarding frames.
- Forwarding: Operates normally by forwarding frames.
- Disabled: No activity on the port.
- 4) Timers:
- Hello Time: Interval between BPDU transmissions (default: 2 seconds).
- Forward Delay: Time spent in the listening and learning states (default: 15 seconds each).
- Max Age: Time before considering a BPDU invalid (default: 20 seconds).
- 5) Redundant Path Management: Blocks redundant paths and only activates them when the primary path fails.

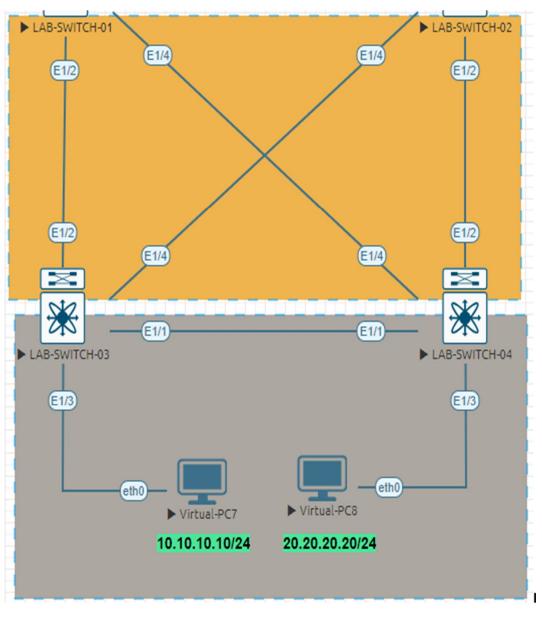
III. LIMITATIONS OF TRADITIONAL STP

- 1) Convergence Time: Takes 30-50 seconds to stabilize the network after a topology change.
- 2) Inefficiency: Redundant links remain blocked, resulting in underutilized bandwidth.
- A. Base Topology





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B. Configuration Details

- Created two Layer 3 VLANs (VLAN 10 and VLAN 20) on LAB-SWITCH-01, making it the Root Bridge for these VLANs.
- Configured LAB-SWITCH-02 as the Backup Root Bridge for both VLANs.
- Assigned Higher HSRP Priority to LAB-SWITCH-01, ensuring it is the active switch for both VLANs.

Switch Roles:

- LAB-SWITCH-01: Root Bridge for VLANs 10 and 20.
- LAB-SWITCH-02: Backup Root Bridge for VLANs 10 and 20.

C. Traffic Flow (Layer 2 STP)

Due to STP:

- Looped interfaces or redundant links are blocked to prevent Layer 2 loops.
- Traffic for VLANs 10 and 20 flows through a single active link, while the second link operates in a standby state.



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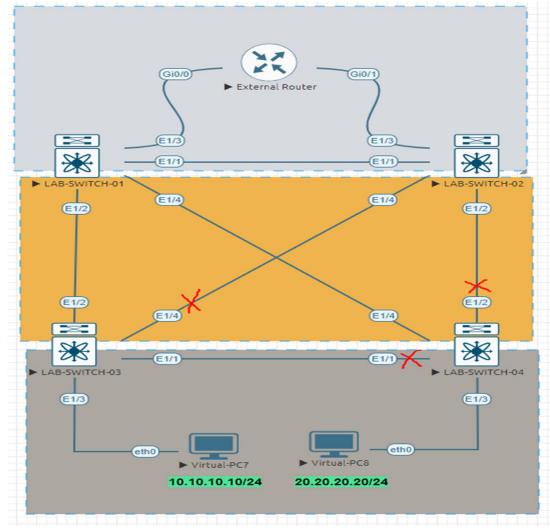
LAB-SWITCH-01 - Root Bridge for Vlan 10, 20

LAB-SWITCH-01# sł	n spanı	ning-tree root					
Vlan		Root ID		Hello Time			Root Port
VLAN0001	32769	5001.0000.1b08	0	2	20	15	This bridge is root
VLAN0010	32778	5001.0000.1b08	0	2	20	15	This bridge is root
VLAN0020	32788	5001.0000.1b08	0	2	20	15	This bridge is root
LAB-SWITCH-01#							

LAB-SWITCH-02 - Backup Root Bridge for Vlan 10, 20

LAB-SWITCH-02# s	ho spanning-tree root					
Vlan	Root ID		Hello Time			Root Port
VLAN0001	32769 5001.0000.1b08	4	2	20	15	Ethernet1/1
VLAN0010	32778 5001.0000.1b08	8	2	20	15	Ethernet1/4
VLAN0020	32788 5001.0000.1b08	8	2	20	15	Ethernet1/4
LAB-SWITCH-02#						

D. Base Topology – Blocking links





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LAB-SWITCH-01: Spanning-Tree status

LAB-SWITCH-0	1# sh spanning-tree vlan 10,20 brief
VLAN0010	
	ree enabled protocol rstp
	Priority 32778
	Address 5001.0000.1b08
	This bridge is the root
	Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
	nerio lime 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID	Priority 32778 (priority 32768 sys-id-ext 10)
	Address 5001.0000.1b08
	Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface	Role Sts Cost Prio.Nbr Type
Eth1/1	Desg FWD 4 128.1 P2p Desg FWD 4 128.2 P2p
Eth1/2	Desg FWD 4 128.2 P2p Desg FWD 4 128.3 P2p
Eth1/3	Desg FWD 4 128.3 P2p
Eth1/4	Desg FWD 4 128.4 P2p
VLAN0020	
	ree enabled protocol rstp
Root ID	Priority 32788
	Address 5001.0000.1b08
	This bridge is the root
	Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID	Priority 32788 (priority 32768 sys-id-ext 20)
	Address 5001.0000.1b08
	Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface	Role Sts Cost Prio.Nbr Type
	Kole StS cost Filo.NSI Type
Eth1/1	Desg FWD 4 128.1 P2p
	Desg FWD 4 128.2 P2p
	Desg FWD 4 128.3 P2p
	Desg FWD 4 128.4 P2p
LAB-SWITCH-0	1#

LAB-SWITCH-02 : Spanning-Tree status

LAB-SWITCH-0	2 # sh spanni	ng-tree vla	n 10,20 k	prief						
VLAN0010										
Spanning tree enabled protocol rstp										
	Priority		сp							
ROOL ID	Address	5001 0000	1209							
	Address Cost	4	1000							
	Port		+1/1)							
				sec Forward Delay 15 sec						
	Hello lime	z sec Ma	x Age 20	sec forward beray is sec						
Bridge TD	Priority	32778 (pr	iority 32	2768 sys-id-ext 10)						
Dirage ib	Address			, to bib id one it,						
				sec Forward Delay 15 sec						
		2 000 110	n ngo bo	bee formara berag to bee						
Interface	Role St	s Cost	Prio.Nbr	г Туре						
 Eth1/1	Root FW	D 4	128.1	P2p						
Eth1/2	Desg FW	D 4 D 4	128.2	P2p						
Eth1/3	Desg FW	D 4	128.3	P2p						
Eth1/4	Desg FW	D 4	128.4	P2p						
VLAN0020										
Spanning t	ree enabled	protocol rs	tp							
Root ID	Priority Address	32788								
		5001.0000.	1b08							
		4								
	Port	1 (Etherne	t1/1)	sec Forward Delay 15 sec						
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15 sec						
	_ • •									
Bridge ID	Priority	32788 (pr	iority 32	2768 sys-id-ext 20)						
	Address	5002.0000.	1608							
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15 sec						
Interface	Role St	s Cost	Prio.Nbr	r Type						
Eth1/1	Root FW	D 4	128.1	P2p						
Eth1/2		D 4								
Eth1/3	Desg FW	D 4	128.3	P2p						
Eth1/4	Desg FW	D 4	128.4	P2p						
LAB-SWITCH-0	2#									



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LAB-SWITCH-03 : Spanning-Tree status

LAB-SWITCH-0	3# sh spanni:	ng-tree vlan 10,20 brief							
VLAN0010									
	ree enabled	protocol rstp							
		Priority 32778							
		5001.0000.1b08							
	Cost	4							
	Port	2 (Ethernet1/2)							
	Hello Time	4 2 (Ethernet1/2) 2 sec Max Age 20 sec Forward Delay 15 sec							
	nerro rime	2 See maxinge 20 See Formatia Deray 10 See							
Bridge ID	Priority	32778 (priority 32768 sys-id-ext 10)							
	Address	5003.0000.1b08							
	Hello Time	2 sec Max Age 20 sec Forward Delay 15 sec							
Interface	Role St	s Cost Prio.Nbr Type							
Eth1/1	Desg FW	D 4 128.1 P2p							
Eth1/2	Root FW	ID 4 128.2 P2p ID 4 128.3 P2p IK 4 128.4 P2p							
Eth1/3	Desg FW	D 4 128.3 P2p							
Eth1/4	Alth BL	K 4 128.4 P2p							
VLAN0020									
	ree enabled	protocol rstp							
	Priority								
ROOL ID		5001.0000.1b08							
	Cost	$\frac{1}{2}$ (Fthernet1/2)							
	Hello Time	2 (Ethernet1/2) 2 sec Max Age 20 sec Forward Delay 15 sec							
	merro rime	2 Set Max Age 20 Set Folward Delay 15 Set							
Bridge ID	Priority	32788 (priority 32768 sys-id-ext 20)							
DILAGO ID		5003.0000.1b08							
		2 sec Max Age 20 sec Forward Delay 15 sec							
Interface	Role St	s Cost Prio.Nbr Type							
Eth1/1	Desg FW	D 4 128.1 P2p							
Eth1/2		ID 4 128.2 P2p							
Eth1/4	Altn BL	K 4 128.4 P2p							
LAB-SWITCH-0	3#								

LAB-SWITCH-04 : Spanning-Tree status

LAB-SWITCH-0	LAB-SWITCH-04# sh spanning-tree vlan 10,20 brief									
VLAN0010										
Spanning tree enabled protocol rstp										
	Priority	32778								
	Address	5001.0000.	1b08							
		4								
	Port	4 (Etherne	t1/4)							
	Hello Time			sec F	orward	Delay 15	sec			
Bridge ID	Priority			2768 sy	s-id-ex	t 10)				
	Address									
	Hello Time	2 sec Ma	x Age 20	sec F	orward	Delay 15	sec			
Interface	Role St	s Cost	Prio.Nb	r Type						
Eth1/1	Altn BL	к 4	128.1	P2p						
Eth1/2										
Eth1/4	Root FW	D 4	128.4	P2p						
				-						
VLAN0020										
	ree enabled		tp							
Root ID	Priority	32788								
	Address	5001.0000.	1b08							
	Cost									
	Port									
	Hello Time	2 sec Ma	x Age 20	sec F	orward	Delay 15	sec			
Bridge TD	Priority	32788 (pr	iority 3	2768 61	s-id-ev	+ 20)				
Dirage in	Address			2,00 51	5 10 01	0 20,				
	Hello Time			sec F	orward	Delav 15	sec			
Interface	Role St	s Cost	Prio.Nb	r Type						
	Altn BL									
Eth1/2	Altn BL	K 4	128.2	P2p						
Eth1/3	Desg FW	D 4 D 4	128.3	P2p						
Eth1/4	Root FW	D 4	128.4	P2p						
LAB-SWITCH-0	4 #									
LAB-SWITCH-0	2 #									



LAB-SWITCH-01: HSRP Status

LAB-SWITCH-0	1 # sh	hsrp	brief			
*:IPv6 group	#:	group	belongs to	a bundle		
		Р	indicates	configured to	preempt.	
Interface	Grp	Prio	P State	Active addr	Standby addr	Group addr
Vlan10	1	110	P Active	local	10.10.10.2	10.10.10.3
(conf)						
Vlan20	2	110	P Active	local	20.20.20.2	20.20.20.3
(conf)						
LAB-SWITCH-0	1#					
	- 11					

LAB-SWITCH-02 : HSRP Status

LAB-SWITCH-0	2 # sh	hsrp	brief			
*:IPv6 group	#:	group	belongs to	a bundle		
		P	indicates of	configured to	preempt.	
Interface	Grp	Prio	P State	Active addr	Standby addr	Group addr
Vlan10	1	100	Standby	10.10.10.1	local	10.10.10.3
(conf)						
Vlan20	2	100	Standby	20.20.20.1	local	20.20.20.3
(conf)			_			
LAB-SWITCH-0	2#					

IV. BUSINESS CHALLENGE

From a business perspective:

- 1) Blocking expensive fiber links leads to resource underutilization.
- 2) All VLAN traffic passing through a single link increases operational costs and reduces network efficiency.

V. IMPLEMENTED SOLUTION

To optimize resource utilization and enhance network performance, the following solutions were implemented: Per-VLAN Spanning Tree (PVST)

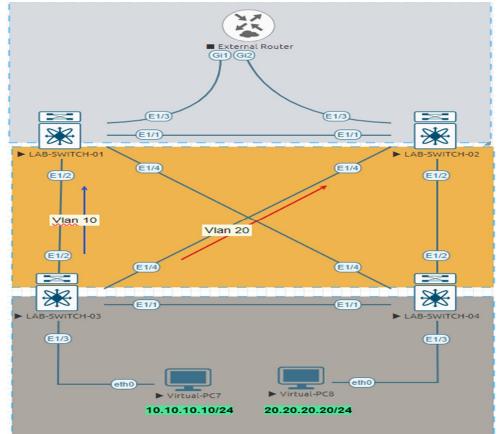
- 1) Configured separate primary and secondary paths for each VLAN to distribute traffic efficiently:
- VLAN 10: Uses Link A as its primary path.
- VLAN 20: Uses Link B as its primary path.
- 2) HSRP Configuration
- 3) Increased HSRP priority for VLAN 20 on the secondary switch to ensure smooth traffic flow at both Layer 2 and Layer 3.
- 4) To address this issue, we have implemented the following solutions to optimize resource utilization and enhance network performance:
- 5) For example, VLAN 10 uses Link A as its primary path, while VLAN 20 uses Link B.

LAB-SWITCH-02(config)# spanning-tree vlan 20 priority 4096



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Base Topology : Traffic Flow per Vlan



LAB-SWITCH-01: Spanning-Tree Status

```
LAB-SWITCH-01# sh spanning-tree vlan 10, 20 brie
VLAN0010
            tree enabled protocol rstp
Priority 32778
  Spanning
  Root ID
                             32778
5001.0000.1b08
               Address
This bridge
                             is
                                the
                                     root
               Hello Time
                                      Max Age 20 sec
                                                         Forward Delay 15 sec
                             2
                                sec
  Bridge ID
                             32778
                                     (priority
                                                32768 sys-id-ext 10)
               Priority
                             5001.0000.1608
               Address
               Hello Time
                                      Max Age 20 sec
                                                         Forward Delay 15 sec
                             2
                                sec
Interface
                   Role Sts Cost
                                          Prio.Nbr Type
Eth1/1
Eth1/2
Eth1/4
                   Desg FWD
                              4
                                          128.1
                                                    P2p
                                                    P2p
P2p
                   Desg
                             44
                                          128.2
                         FWD
                   Desg FWD
VLAN0020
  Spanning
                  enabled protocol rstp
             tree
  Root ID
               Priority
                             4116
               Address
                             5002.0000.1b08
               Cost
                             4
                               (Ethernet1/1)
               Port
               Hello Time
                             2
                                sec
                                      Max Age 20 sec
                                                         Forward Delay 15 sec
               Priority
                             32788
                                     (priority 32768 sys-id-ext 20)
  Bridge ID
               Address
                             5001.0000.1b08
               Hello Time
                             2
                                sec
                                     Max Age 20
                                                   sec
                                                         Forward Delay 15 sec
Interface
                   Role Sts
                              Cost
                                          Prio.Nbr Type
                                          128.1
                                                    92p
92p
92p
Eth1/1
                   Root FWD
                              4
Eth1/2
Eth1/4
                              4
                         FWD
                                          128.2
                   Desg
                   Desg FWD
                              4
                                          128.4
LAB-SWITCH-01#
```



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LAB-SWITCH-02: Spanning-Tree Status

LAB-SWITCH-02# sh spanning-tree vlan 10, 20 brie										
VLAN0010										
	ree enabled		tp							
Root ID	Priority	32778								
	Address		1b08							
	Cost	4								
	Port	1 (Etherne	t1/1)							
	Hello Time	2 sec Ma	x Age 20	sec	Forward	Delay 1	5 sec			
Bridge ID	Address	5002.0000.			-					
	Hello Time	2 sec Ma	x Age 20	sec	Forward	Delay 1	5 sec			
Interface	Role St	s Cost	Prio.Nbr	туре	2					
Eth1/1	Root FW	D 4	128.1	P2p						
Eth1/2	Desg FW		128.2	-						
Eth1/4	Desg FW	D 4	128.4	P2p						
VLAN0020										
Spanning t	ree enabled	protocol rs	tp							
Root ID	Priority	4116								
	Address									
	This bridge									
	Hello Time	2 sec Ma	x Age 20	sec	Forward	Delay 1	5 sec			
Bridge ID	Priority Address	4116 (pr 5002.0000.	iority 40 1b08)96 sy	ys-id-ext	20)				
	Hello Time	2 sec Ma	x Age 20	sec	Forward	Delay 1	5 sec			
Interface	Role St	s Cost	Prio.Nbr	Type	e 					
Eth1/1	Desg FW	D 4	128.1	P2p						
Eth1/2	Desg FW	D 4	128.2	P2p						
Eth1/4	Desg FW	D 4	128.4	P2p						
LAB-SWITCH-0	2#									

LAB-SWITCH-03: Spanning-Tree Status

LAB-SWITCH-0	3 # sh spanni	ng-tree vla	n 10, 20	brie						
VLAN0010										
Spanning tree enabled protocol rstp										
	Priority		сp							
1000 12	Address	5001 0000	1608							
	Cost	4	12000							
	Port	2 (Etherne	$\pm 1/2)$							
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15	sec					
Bridge ID	Priority	32778 (pr	ioritv 32	2768 svs-id-ext 10)						
2	Address	5003.0000.	1ь08	2768 sys-id-ext 10)						
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15	sec					
Interface	Role St	s Cost	Prio.Nbr	Туре						
Eth1/1	Desg FW	P 4	128.1	P2p						
Eth1/2		D 4								
Eth1/3	Desg FW	D 4	128.3	P2p						
Eth1/4	Desg FW Altn BL	K 4	128.4	P2p						
				2 - P						
VLAN0020										
	ree enabled	protocol re	tro							
	Priority		CP							
	Address		1608							
	Cost Port	4 (Etherne	(1/4)							
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15	sec					
			i iigo bo	bee rermara beraj re						
Bridge ID	Priority	32788 (pr	iority 32	2768 sys-id-ext 20)						
	Hello Time	2 sec Ma	x Age 20	sec Forward Delay 15	sec					
Interface	Role St	s Cost	Prio.Nbr	Type						
	Desg FW									
Eth1/2										
Eth1/4	ROOT FW	D 4	128.4	P2p						
LAB-SWITCH-0	2 #									
LAB-SWITCH-0	→ #									



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LAB-SWITCH-04: Spanning-Tree Status

LAB-SWITCH-04# sh spanning-tree vlan 10, 20 brie										
VLAN0010										
Spanning tree enabled protocol rstp										
	ID Priority 32778									
	Address		1b08							
	Cost	4								
	Cost Port	4 (Ethernet	t1/4)							
	Hello Time	2 sec Max	x Age 20	sec Forward	Delay 15 sec					
Bridge ID	Priority Address	32778 (pr: 5004.0000.3	iority 32 1b08	768 sys-id-e	xt 10)					
	Hello Time	2 sec Max	x Age 20	sec Forward	Delay 15 sec					
Interface	Role St	s Cost 	Prio.Nbr	Туре						
Eth1/1	Altn BL	K 4	128.1	P2p						
Eth1/2	Altn BL	K 4	128.2	P2p						
Eth1/4										
				-						
VLAN0020										
	ree enabled		tp							
Root ID	Priority	4116								
	Address	5002.0000.1	1608							
	Cost Port	4	1 (2)							
	Port Hollo mimo	2 (Etherner	L1/2)	Foruard	Delay 15 sec					
	Hello Time	z sec Mar	x Age 20	sec Forward	Delay 15 Sec					
Bridge ID	Priority Address	32788 (pr:	iority 32	768 sys-id-e	xt 20)					
	Hello Time	2 sec Max	x Age 20	sec Forward	Delay 15 sec					
Interface	Role St	s Cost 	Prio.Nbr	Туре						
Eth1/1	Altn BL	к 4	128.1	P2p						
Eth1/2										
Eth1/3										
Eth1/4	Altn BL	к 4	128.4	P2p						
LAB-SWITCH-0										

We need to increase the HSRP priority for VLAN 20 on the secondary switch to ensure smooth traffic flow not only at Layer 2 but also at Layer 3

LAB-SWITCH-02: HSRP Status

5 WIICH-02. HSKI	- Status	,							
LAB-SWITCH-0	2 # sh	ow hsr	p brief						
*:IPv6 group #:group belongs to a bundle									
	P indicates configured to preempt.								
		1							
Interface	Grp	Prio	P State	Active addr	Standby addr	Group addr			
Vlan10	1	100	Standby	10.10.10.1	local	10.10.10.3			
(conf)									
Vlan20	2	120	P Active	local	20.20.20.1	20.20.20.3			
(conf)									
LAB-SWITCH-0	2#								



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LAB-SWITCH-01: HSRP Status

LAB-SWITCH-0 *:IPv6 group		group	belongs to	a bundle configured to	preempt.	
Interface	Grp	Prio	P State	Active addr	Standby addr	Group addr
Vlan10 (conf)	1	110	P Active	local	10.10.10.2	10.10.10.3
Vlan20 (conf) LAB-SWITCH-0	2 1#	110	P Standby	20.20.20.2	local	20.20.20.3

VI. CISCO VIRTUAL PORT-CHANNEL (vPC)

Cisco's Virtual Port-Channel (vPC) is a groundbreaking feature available on Nexus switches. It enables two switches to function as a single logical switch to downstream devices, ensuring high availability, redundancy, and loop-free topologies.

A. Why vPC is Needed?

Traditional Layer 2/Layer 3 designs heavily relied on STP, which has limitations:

- Redundant Path Blocking: STP blocks redundant links, wasting valuable bandwidth.
- Convergence Delays: Topology changes can cause high delays, impacting performance.
- B. vPC Advantages
- Enables active-active forwarding on multiple links.
- Eliminates STP blocking on redundant paths.
- Provides faster convergence, ensuring high availability.
- C. Key Benefits of vPC
- 1) Reduces STP Dependency: Minimizes reliance on STP for loop prevention.
- 2) Maximizes Link Utilization: Supports active-active forwarding, using all available links.
- 3) Simplifies Network Architecture: Makes dual-homed device configurations straightforward.
- 4) Improves Reliability and Performance: Enhances network uptime and efficiency.
- D. Base vPC Configuration
- 1) vPC Peer-Link

A dedicated port-channel between two Nexus switches for synchronization.

2) Downstream Devices

Devices connected to both switches via active-active links, leveraging vPC for optimal bandwidth and redundancy.

LAB-SWITCH-01: vPC status

```
LAB-SWITCH-01# sh run | sec vpc
feature vpc
vpc domain 1
role priority 100
peer-keepalive destination 1.1.1.2 source 1.1.1.1 vrf default
vpc peer-link
vpc 51
vpc 52
LAB-SWITCH-01#
```



LAB-SWITCH-02

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LAB-SWITCH-02: vPC status

```
LAB-SWITCH-02# sh run | sec vpc
feature vpc
vpc domain 1
role priority 200
peer-keepalive destination 1.1.1.1 source 1.1.1.2 vrf default
vpc peer-link
vpc 51
vpc 52
LAB-SWITCH-02#
```

Configuration for the downstream interface connected to the downstream switches LAB-SWITCH-01

```
interface port-channel1
  switchport mode trunk
  spanning-tree port type network
  vpc peer-link
interface port-channel51
  switchport mode trunk
  vpc 51
interface port-channel52
  switchport mode trunk
  vpc 52
LAB-SWITCH-01#
interface port-channel1
   switchport mode trunk
  spanning-tree port type network
  vpc peer-link
interface port-channel51
   switchport mode trunk
  vpc 51
interface port-channel52
   switchport mode trunk
  vpc 52
 LAB-SWITCH-02#
```



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LAB-SWITCH-03 : Active interfaces connected to northbound devices

Group	Port- Channel	Туре	Protocol	Member Ports	
10 LAB-SI	Po10(SU) WITCH-03#	Eth	LACP	Eth1/2(P)	Eth1/4(P)

LAB-SWITCH-04 : Active interfaces connected to northbound devices

Group	Port- Channel	Туре	Protocol	Member Ports	
10 LAB-SV	Po10(SU) WITCH-04#	Eth	LACP	Eth1/2(P)	Eth1/4(P)

LAB-SWITCH-03 : Traffic is passing through both links without any blockage.

```
LAB-SWITCH-03# sh spanning-tree vlan 10,20 brief
VLAN0010
  Spanning tree enabled protocol rstp
  Root ID
             Priority
                         32778
             Address
                         5001.0000.1b08
            Cost
                         3
             Port
                         4105 (port-channel10)
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Bridge ID Priority
                         32778
                                (priority 32768 sys-id-ext 10)
             Address
                         5003.0000.1b08
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface
                Role Sts Cost
                                    Prio.Nbr Type
Po10
                Root FWD 3
                                    128.4105 P2p
Eth1/3
                Desg FWD 4
                                    128.3
                                             P2p
VLAN0020
  Spanning tree enabled protocol rstp
  Root ID
             Priority
                         32788
             Address
                         5001.0000.1b08
             Cost
                         3
                         4105 (port-channel10)
             Port
             Hello Time 2
                           sec Max Age 20 sec Forward Delay 15 sec
 Bridge ID
            Priority
                         32788
                                (priority 32768 sys-id-ext 20)
             Address
                         5003.0000.1b08
             Hello Time
                         2 sec Max Age 20 sec Forward Delay 15 sec
Interface
                 Role Sts Cost
                                    Prio.Nbr Type
Po10
                 Root FWD 3
                                    128.4105 P2p
LAB-SWITCH-03#
```



LAB-SWITCH-04 : Traffic is passing through both links without any blockage.

```
LAB-SWITCH-04# sh spanning-tree vlan 10,20 brief
VLAN0010
  Spanning tree enabled protocol rstp
 Root ID
             Priority
                         32778
             Address
                         5001.0000.1b08
             Cost
                         3
                         4105 (port-channel10)
             Port
             Hello Time
                         2
                            sec Max Age 20 sec Forward Delay 15 sec
 Bridge ID
             Priority
                         32778
                                 (priority 32768 sys-id-ext 10)
             Address
                         5004.0000.1b08
                            sec Max Age 20 sec
             Hello Time
                         2
                                                  Forward Delay 15 sec
Interface
                 Role Sts Cost
                                     Prio.Nbr Type
                 Root FWD 3
Po10
                                     128.4105 P2p
VLAN0020
 Spanning tree enabled protocol rstp
  Root ID
             Priority
                         32788
                         5001.0000.1b08
             Address
             Cost
                         3
             Port
                         4105 (port-channel10)
             Hello Time
                         2
                            sec
                                 Max Age 20 sec Forward Delay 15 sec
             Priority
                                 (priority 32768 sys-id-ext 20)
 Bridge ID
                         32788
             Address
                         5004.0000.1b08
             Hello Time
                            sec Max Age 20 sec Forward Delay 15 sec
                         2
Interface
                 Role Sts Cost
                                     Prio.Nbr Type
Po10
                                     128.4105 P2p
                 Root FWD 3
Eth1/3
                 Desg FWD 4
                                     128.3
                                              P2p
LAB-SWITCH-04#
```

VII. CONCLUSION

With the implementation of PVST and vPC, we addressed inefficiencies in traditional STP by enabling better resource utilization and ensuring a robust, scalable, and high-performing network. By increasing HSRP priority for VLAN 20 on the secondary switch, traffic flow has been optimized at both Layer 2 and Layer 3, enhancing overall network stability and business operations.











45.98



IMPACT FACTOR: 7.129







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