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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.

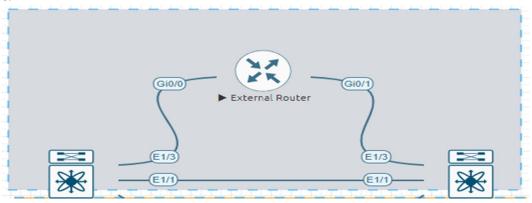
II. KEY FEATURES OF TRADITIONAL STP

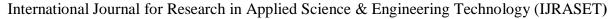
- 1) IEEE Standard: Defined by the IEEE 802.1D specification.
- 2) Root Bridge Election: Utilizes Bridge Protocol Data Units (BPDUs) to elect a Root Bridge, which acts as the central reference point in the network topology.
- 3) Port States:
- Blocking: Prevents loops by not forwarding frames.
- Listening: 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

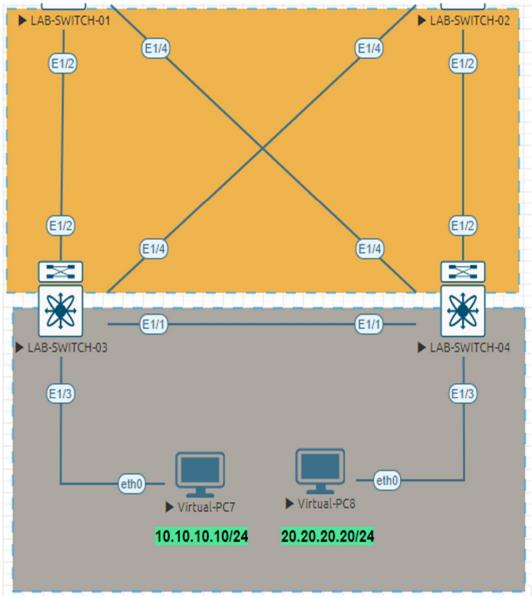
- 1) Convergence Time: Takes 30-50 seconds to stabilize the network after a topology change.
- 2) Inefficiency: Redundant links remain blocked, resulting in underutilized bandwidth.

A. Base Topology









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.





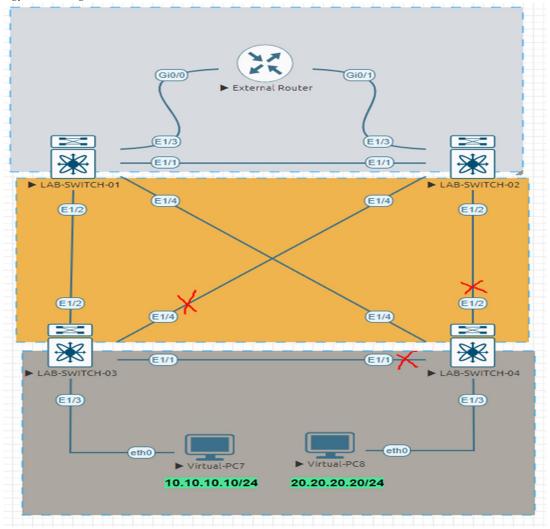
LAB-SWITCH-01 - Root Bridge for Vlan 10, 20

LAB-SWITCH-01# sh spanning-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#	sho spar	ning-tree root					
Vlan		Root ID		Hello Time			Root Port
VLAN0001		5001.0000.1b08	4	2	20	15	Ethernet1/1
VLAN0010 VLAN0020		5001.0000.1b08 5001.0000.1b08	8	2		15 15	Ethernet1/4 Ethernet1/4
LAB-SWITCH-02#	32,00	5001.0000.1200	-	2	20	10	Editation 1

D. Base Topology - Blocking links







LAB-SWITCH-01: Spanning-Tree status

```
LAB-SWITCH-01#
                sh spanning-tree vlan 10,20 brief
VLAN0010
  Spanning tree enabled protocol rstp
Root ID Priority 32778
Address 5001.0000.1b08
              This bridge is the root
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID Priority 32778 (priority 32768 sys-id-ext 10)
Address 5001.0000.1b08
                           5001.0000.1b08
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                  Role Sts Cost
Interface
                                        Prio.Nbr Type
Eth1/1
Eth1/2
                  Desg FWD 4
                                        128.1
                                                   P2p
                  Desg FWD 4
                                        128.2
                                                   P2p
Eth1/3
                  Desg FWD 4
                                                   P2p
                  Desg FWD 4
VLAN0020
  Spanning tree enabled protocol rstp
              Priority 32788
Address 5001.0000.1b08
  Root ID
              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
Eth1/1
Eth1/2
                  Desg FWD 4
                                        128.1
                                                   P2p
                  Desg FWD 4
                                        128.2
                                                   P2p
Eth1/3
                   Desg FWD 4
                                        128.3
                                                   P2p
                   Desg FWD 4
Eth1/4
LAB-SWITCH-01#
```

LAB-SWITCH-02: Spanning-Tree status

```
LAB-SWITCH-02# sh spanning-tree vlan 10,20 brief
VLAN0010
  Spanning tree enabled protocol rstp
Root ID Priority 32778
                         32778
5001.0000.1b08
               Address
               Hello Time 2 sec M
                                 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID
              Priority
                                      (priority 32768 sys-id-ext 10)
               Address
                              5002.0000.1b08
               Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface
                    Role Sts Cost
                                          Prio.Nbr Type
                    Root FWD 4
Desg FWD 4
                                  128.1
Eth1/1
                                                     P2p
Eth1/2
Eth1/3
Eth1/4
                                                      P2p
                                           128.2
                    Desg FWD 4
Desg FWD 4
                                           128.3
128.4
                                                      P2p
VI.ANOO2O
  Spanning tree enabled protocol rstp
               Priority 32788
Address 5001.0000.1b08
Cost 4
Port 1 (Ethernet1/1
               Port 1 (Ethernet1/1)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
              Priority 32788
                                      (priority 32768 sys-id-ext 20)
  Bridge ID
               Address
                              5002.0000.1b08
               Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface
                    Role Sts Cost
                                          Prio.Nbr Type
                   Root FWD 4
Desg FWD 4
Desg FWD 4
Desg FWD 4
                                                     P2p
Eth1/1
Eth1/2
Eth1/3
                                          128.1
                                          128.2
                                                     P2p
                                           128.3
                                                      P2p
Eth1/4
                                           128.4
LAB-SWITCH-02#
```



LAB-SWITCH-03: Spanning-Tree status

```
LAB-SWITCH-03# sh spanning-tree vlan 10,20 brief
VLAN0010
  Spanning tree enabled protocol rstp
               Priority
  Root ID
               Address
                              5001.0000.1b08
               Cost
               Port
                             2 (Ethernet1/2)
               Hello Time 2
                                 sec Max Age 20 sec Forward Delay 15 sec
                           32778 (priority 32768 sys-id-ext 10) 5003.0000.1b08
  Bridge ID Priority
               Address 5003.0000.1b08
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                    Role Sts Cost
Interface
                                           Prio.Nbr Type
Eth1/1
Eth1/2
                    Desg FWD 4
Root FWD 4
                                           128.1
                                                      P2p
                                           128.2
                                                      P2p
Eth1/3
Eth1/4
                                                      P2p
                    Desg FWD 4
                                           128.3
                                                      P2p
                    Altn BLK 4
                                           128.4
VLAN0020
  Spanning tree enabled protocol rstp
               Priority 32788
Address 5001.0000.1b08
Cost 4
Port 2 (Ethernet1/2)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Root ID
                             32788 (priority 32768 sys-id-ext 20) 5003.0000.1b08
  Bridge ID Priority 32788
               Address 5003.0000.1b08
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                    Role Sts Cost
                                           Prio.Nbr Type
Interface
                 Desg FWD 4
Root FWD 4
Eth1/1
Eth1/2
                                      128.1
                                                      P2p
                                           128.2
                                                      P2p
                                          128.4
                   Altn BLK 4
LAB-SWITCH-03#
```

LAB-SWITCH-04 : Spanning-Tree status

```
LAB-SWITCH-04# sh spanning-tree vlan 10,20 brief
/LAN0010
  Spanning tree enabled protocol rstp
Root ID Priority 32778
Address 5001.0000.1b0
                                   32778
5001.0000.1b08
                  Cost
                  Port 4 (Ethernet1/4)
Hello Time 2 sec Max Age
                                       sec Max Age 20 sec Forward Delay 15 sec
                               32778
                                   32778 (priority 32768 sys-id-ext 10)
5004.0000.1b08
2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID Priority
                  Address
Hello Time
                       Role Sts Cost
                                                  Prio.Nbr Type
Interface
                                                  128.1
Eth1/1
                       Altn BLK 4
                                                               P2p
Eth1/2
Eth1/4
                                                               P2p
P2p
                       Altn BLK 4
                       Root FWD 4
                                                   128.4
VLAN0020
  ANUU20
Spanning tree enabled protocol rstp
Root ID Priority 32788
Address 5001.0000.1b08
                  Cost 4
Port 4 (Ethernet1/4)
Hello Time 2 sec Max Age
                                       sec Max Age 20 sec Forward Delay 15 sec
                                   32788 (priority 32768 sys-id-ext 20) 5004.0000.1b08
  Bridge ID Priority 32788
                  Address 5004.0000.1b08
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                       Role Sts Cost
Interface
                                                  Prio.Nbr Type
Eth1/1
Eth1/2
Eth1/3
Eth1/4
                       Altn BLK 4
Altn BLK 4
                                                  128.1
128.2
                                                               P2p
                                                                P2p
                       Desg FWD 4
Root FWD 4
                                                   128.3
                                                   128.4
 AB-SWITCH-04#
```





LAB-SWITCH-01: HSRP Status

```
LAB-SWITCH-01# sh hsrp brief
              #:group belongs to a bundle
*:IPv6 group
                    P indicates configured to preempt.
 Interface
            Grp Prio P State
                                 Active addr
                                                  Standby addr
                                                                   Group addr
 Vlan10
                  110 P Active local
                                                   10.10.10.2
                                                                    10.10.10.3
     (conf)
 Vlan20
                  110 P Active local
                                                   20.20.20.2
                                                                    20.20.20.3
     (conf)
LAB-SWITCH-01#
```

LAB-SWITCH-02: HSRP Status

```
LAB-SWITCH-02# sh hsrp brief
*:IPv6 group
               #:group belongs to a bundle
                     P indicates configured to preempt.
             Grp Prio P State
                                  Active addr
                                                    Standby addr
 Interface
                                                                      Group addr
                                                                       10.10.10.3
 Vlan10
                          Standby 10.10.10.1
                                                     local
                   100
     (conf)
                                                                       20.20.20.3
  Vlan20
                   100
                          Standby 20.20.20.1
                                                     local
     (conf)
LAB-SWITCH-02#
```

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:

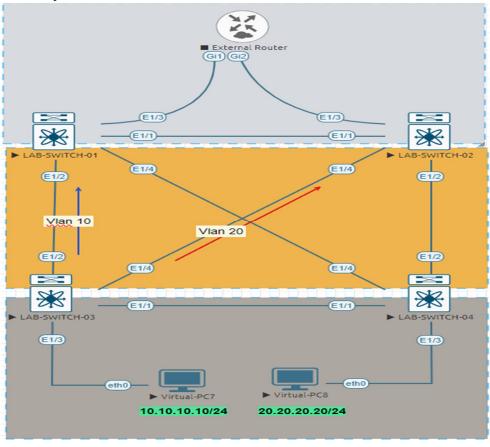
Per-VLAN Spanning Tree (PVST)

- 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



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



LAB-SWITCH-02: Spanning-Tree Status

```
sh spanning-tree vlan 10, 20 brie
LAB-SWITCH-02#
VLAN0010
  Spanning tree enabled protocol rstp
            Priority
                        32778
  Root ID
             Address
                        5001.0000.1b08
                  4
1 (Ethernet1/1)
             Cost
             Port
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID Priority 32778 (priority 32768 sys-id-ext 10)
             Address
                         5002.0000.1b08
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface
                 Role Sts Cost
                                    Prio.Nbr Type
Eth1/1
                                    128.1
                                              P2p
                Root FWD 4
                                              P2p
                 Desg FWD 4
Eth1/2
                                    128.2
Eth1/4
                                    128.4
                 Desg FWD 4
VLAN0020
  Spanning tree enabled protocol rstp
            Priority 4116
  Root ID
             Address
                         5002.0000.1b08
             This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                      4116 (prioria 5002.0000.1b08
                                (priority 4096 sys-id-ext 20)
  Bridge ID Priority
             Address
             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
                                    128.2
Eth1/2
                 Desg FWD 4
                                              P2p
                 Desg FWD 4
Eth1/4
                                    128.4
                                              P2p
LAB-SWITCH-02#
```

LAB-SWITCH-03: Spanning-Tree Status

```
LAB-SWITCH-03# sh spanning-tree vlan 10, 20 brie
 /LAN0010
   RN0016
Spanning tree enabled protocol rstp
Root ID Priority 32778
Address 5001.0000.1b08
                   Cost
                                   4
2 (Ethernet1/2)
2 sec Max Age 20 sec Forward Delay 15 sec
                   Port
                   Hello Time
                  Priority
  Bridge ID
                                    32778
                                              (priority 32768 sys-id-ext 10)
                  Address 5003.0000.1b08
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                                                 Prio.Nbr Type
                        Role Sts Cost
Interface
                        Desg FWD 4
Root FWD 4
Desg FWD 4
Altn BLK 4
Eth1/1
Eth1/2
Eth1/3
Eth1/4
                                                    128.1
                                                                 P2p
                                                                 P2p
P2p
P2p
P2p
                                                    128.2
VLAN0020
                      enabled protocol rstp
   Spanning tree
                  Priority 4116
Address 5002.0000.1b08
Cost 4
(Fibernet1/4
   Root ID
                  Cost 4
Port 4 (Ethernet1/4)
Hello Time 2 sec Max Age
                                        sec Max Age 20 sec Forward Delay 15 sec
                  Priority
                                    32788 (priority 32768 sys-id-ext 20)
5003.0000.1b08
2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID
                                    32788
                   Address
Hello Time
Interface
                        Role Sts Cost
                                                    Prio.Nbr Type
                                                    128.1
128.2
128.4
Eth1/1
Eth1/2
                        Desg FWD 4
                                                                 P2p
                        Altn BLK 4
Root FWD 4
                                                                 P2p
P2p
Eth1/4
LAB-SWITCH-03#
```



LAB-SWITCH-04: Spanning-Tree Status

```
LAB-SWITCH-04# sh spanning-tree vlan 10, 20 brie
VLAN0010
  Spanning tree enabled protocol rstp
  Root ID
            Priority
                       32778
            Address
                       5001.0000.1b08
            Cost
                 4 (Ethernet1/4)
            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
            Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
                                Prio.Nbr Type
Interface
               Role Sts Cost
 ______ ____
              Altn BLK 4
                               128.1
Eth1/1
                                         P2p
              Altn BLK 4
                               128.2
Eth1/2
                                         P2p
Eth1/4
               Root FWD 4
                               128.4
                                         P2p
VLAN0020
  Spanning tree enabled protocol rstp
  Root ID
           Priority
                     4116
            Address
                     5002.0000.1b08
                      4
            Cost
            Port 2 (Ethernet1/2)
            Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
 Bridge ID Priority
                       32788 (priority 32768 sys-id-ext 20)
            Address
                      5004.0000.1b08
           Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Interface
               Role Sts Cost
                                Prio.Nbr Type
Eth1/1
               Altn BLK 4
                                128.1
                                         P2p
Eth1/2
               Root FWD 4
                                128.2
                                         P2p
Eth1/3
               Desg FWD 4
                                128.3
                                         P2p
Eth1/4
               Altn BLK 4
                                128.4
                                         P2p
LAB-SWITCH-04#
```

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

```
LAB-SWITCH-02# show hsrp brief
*:IPv6 group #:group belongs to a bundle
                   P indicates configured to preempt.
                                                Standby addr
Interface
            Grp Prio P State
                                Active addr
                                                                Group addr
                                                                10.10.10.3
                 100
 Vlan10
                       Standby 10.10.10.1
                                                local
     (conf)
             2
 Vlan20
                 120 P Active
                                 local
                                                 20.20.20.1
                                                                 20.20.20.3
    (conf)
LAB-SWITCH-02#
```

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LAB-SWITCH-01: HSRP Status

```
LAB-SWITCH-01# sh hsrp brief
 :IPv6 group
               #:group belongs to a bundle
                     P indicates configured to preempt.
                                   Active addr
                                                     Standby addr
 Interface
                  Prio P State
                                                                       Group addr
                                                      10.10.10.2
                                                                        10.10.10.3
  Vlan10
                   110
                        P Active
                                    local
              1
     (conf)
                   110 P Standby
                                    20.20.20.2
                                                      local
                                                                        20.20.20.3
  Vlan20
     (conf)
   -SWITCH-01#
```

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: 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#
```

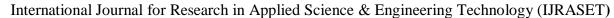
LAB-SWITCH-02

```
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#
```





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

Group	Port- Channel	Туре	Protocol	Member Ports	
10 LAB-S	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
                        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
                        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
             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.





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45.98



IMPACT FACTOR: 7.129



IMPACT FACTOR: 7.429



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