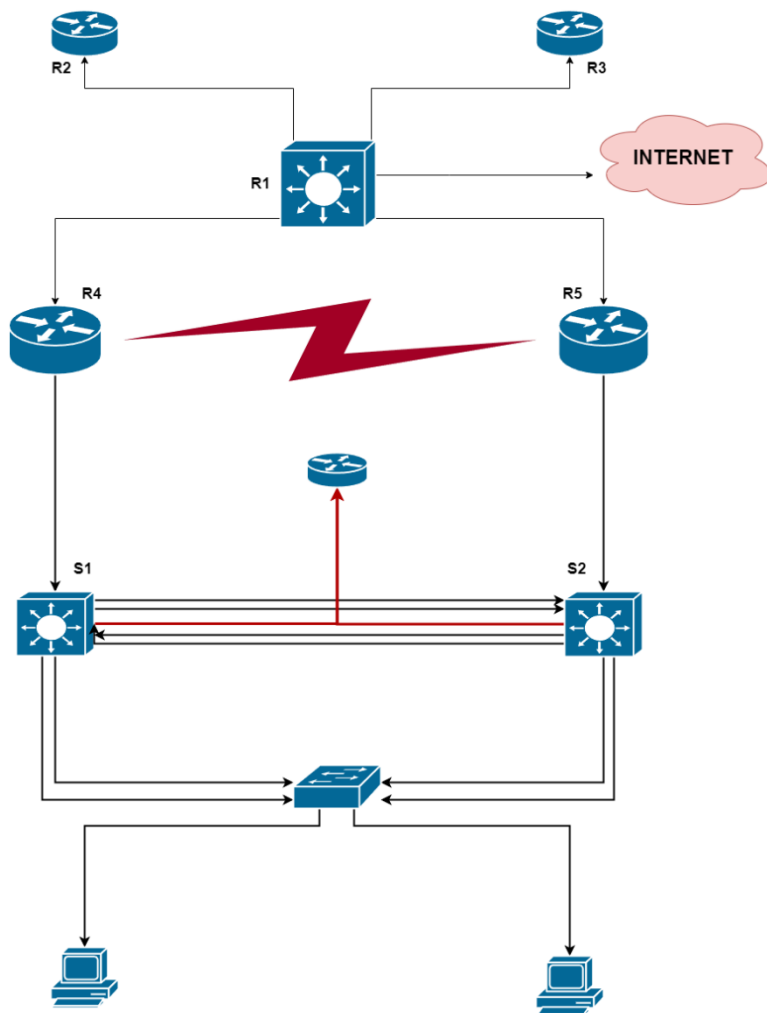


# Designing and Implementing Network Infrastructure



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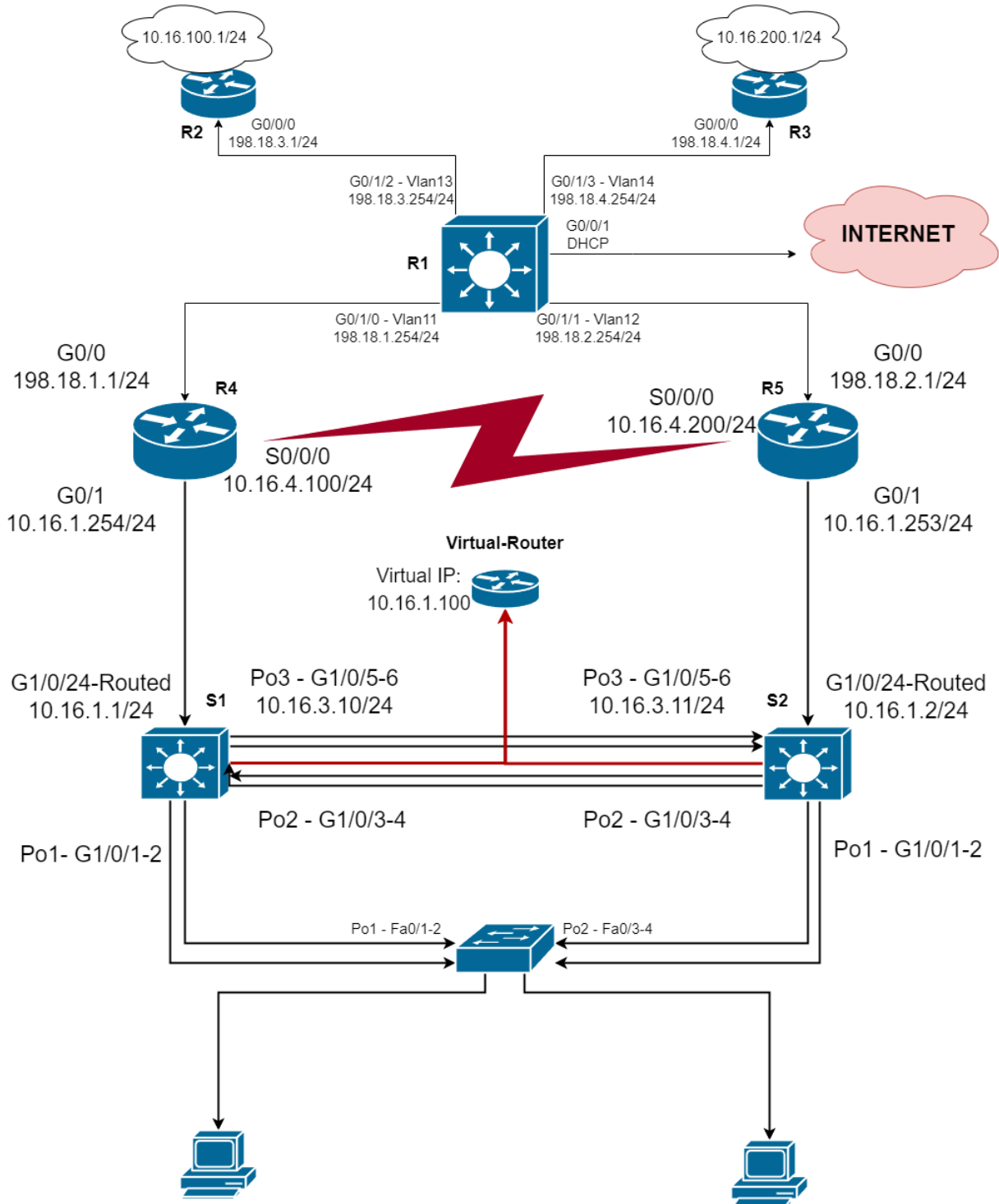
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# Network Infrastructure Topology



# Overview

The report provides an overview of a network infrastructure which includes Service Provider Edge and Customer Edge networking using Cisco routers and switches.

## **Dynamic Multipoint Virtual Private Network (DMVPN):**

- used to provide site-to-site link to each site through the Provider's Edge.

## **EtherChannel:**

- configured on S1, S2 and S3 to provide redundancy by grouping multiple physical links into a single logical link.

**Multiple-Spanning Tree Protocol (MSTP):** This will reduce network convergence time and enables load balancing by spanning traffic across multiple VLANS.

- Configured on Switch 1 and Switch 2. Switch 1 will act as the primary STP for VLAN 10 to 11, and Switch 2 will act as the primary STP for VLAN 12 to 14.

**Hot Standby Routing Protocol:** Creates a virtual router that groups routing devices together. Ensures that if the primary device fails, a standby router will immediately take over.

**Network Address Translation (NAT):** allows internal network and sites to access the internet.

- NAT is configured on the Customer Edge and Provider Edge routers.

**Multi-Protocol Label Switching (MPLS):** directs network traffic from one device to the other by applying labels to each data packet.

- Configured on each customer edge router.

**Customer Edge (CE):** connects to the service provider's network to router traffic between customer sites and provider's network.

**Provider Edge (PE):** located at the edge of the service provider's network. Routes traffic between the provider's backbone network and the customer's network.

# IP Addressing Scheme

## VLAN IP Addressing

VLAN ID	Name	IPv4 Address
10	Data	10.16.10.0/24
11	Voice	10.16.10.0/24
12	Server	10.16.10.0/24
13	Wireless	10.16.10.0/24
14	Guest	10.16.10.0/24
15	NetMngt	10.16.15.0/24
222	ParkingLot	10.16.24.0/24
333	NativeVlan	10.16.28.0/24

## DMVPN Tunnel IP Addressing

Tunnel	Devices	IPv4 Address
Tunnel 1	R2 (hub)	50.16.1.2
Tunnel 1	R3 (spoke)	50.16.1.3
Tunnel 1	R4 (spoke)	50.16.1.4
Tunnel 1	R5 (spoke)	50.16.1.5

## HSRP Tunnel IP Addressing

VLANS	Switch 1 IP	Switch 2 IP	HSRP VIP
V10 - Data	10.16.10.254	10.16.10.253	10.16.10.252
V11 - Voice	10.16.11.254	10.16.11.253	10.16.11.252
V12 - Server	10.16.12.254	10.16.12.253	10.16.12.252
V13 - WLess	10.16.13.254	10.16.13.253	10.16.13.252
V14 - Guest	10.16.14.254	10.16.14.253	10.16.14.252
V15 - NetMngt	10.16.15.254	10.16.15.253	10.16.15.252

## Device IP Addressing

Device	Interface	IPv4 Address	IPv6 Address
R1	G0/0/1	DHCP	
	G0/1/0 (Vlan 11)	198.18.1.254/24	2001:198:18:1::254/64
	G0/1/1 (Vlan 12)	198.18.2.254/24	2001:198:18:2::254/64
	G0/1/2 (Vlan 13)	198.18.3.254/24	2001:198:18:3::254/64
	G0/1/3 (Vlan 14)	198.18.4.254/24	2001:198:18:4::254/64
R4	G0/0	198.18.1.1/24	2001:198:18:1::1/64
	G0/1	10.16.1.254/24	2001:10:16:1::254/64
	S0/0/0	10.16.4.100/24	2001:10:16:4::100/64
R5	G0/0	198.18.2.1/24	
	G0/1	10.16.2.254/24	2001:10:16:2::254/64
	S0/0/0	10.16.4.200/24	2001:10:16:4::200/64
R2	G0/0/0	198.18.3.1/24	2001:198:18:3::1/64
	G0/0/1 (Site 2)	10.16.100.1/24	2001:172:16:1::1/64
R3	G0/0/0	198.18.4.1/24	2001:198:18:5::1/64
	G0/0/1 (Site 3)	10.16.200.1/24	2001:172:16:2::1/64
S1	G1/0/24 (Routed)	10.16.1.1/24	2001:10:16:1::1/64
	G1/0/1-2 (Po1) {Layer 2}	trunk	trunk
	G1/0/3-4 (Po2) {Layer 2}	trunk	trunk
	G1/0/5-6 (Po3) {Layer 3}	10.16.3.10-11/24	2001:10:16:3::10-11/64
S2	G1/0/24 (Routed)	10.16.1.2	2001:10:16:1::2/64
	G1/0/1-2 (Po1) {Layer 2}	trunk	trunk
	G1/0/3-4 (Po2) {Layer 2}	trunk	trunk
	G1/0/5-6 (Po3) {Layer 3}	10.16.3.12-13/24	2001:10:16:3::12-13/64
PC1	PC1-NIC-B (Vlan 10)		
Server1	Server1-NIC-B		

# Device Configuration Information

## Switch Block

### L3 Switch – 1

Device	Interface	IPv4 Address	IPv6 Address
S1	G1/0/24 (Routed)	10.16.1.1/24	2001:10:16:1::1/64
	G1/0/1-2 (Po1) {Layer 2}	trunk	trunk
	G1/0/3-4 (Po2) {Layer 2}	trunk	trunk
	G1/0/5-6 (Po3) {Layer 3}	10.16.3.10-11/24	2001:10:16:3::10-11/64

- **Interfaces**
  - All unused ports are placed in VLAN 222 and shutdown.
- **EtherChannel**
  - Provides fault-tolerance between switch block devices.
  - Channel Group
    - G1/0/1: Channel Group 1 – Mode: Desirable
    - G1/0/2: Channel Group 1 – Mode: Desirable
    - G1/0/3: Channel Group 2 – Mode: Desirable
    - G1/0/4: Channel Group 2 – Mode: Desirable
    - G1/0/5: Channel Group 3 – Mode: Active
    - G1/0/6: Channel Group 3 – Mode: Active
  - All EtherChannel interfaces are configure with the following.
    - Native VLAN: 333
    - Trunk Allowed: VLAN 10-15,222,333
- **Multiple Spanning-Tree (MST)**
  - Instance 1: VLAN 10-11 Primary
  - instance 2: VLAN 12-14 Secondary
- **Hot Standby Router Protocol (HSRP)**
  - L3 Switch – 1 is the active router with a priority of 110 for all VLANS.
- **(L3 Switch-1) Cont.Routing**
  - OSPF is configured to detect networking devices.
    - Area: 16
    - Router ID 10.10.10.10
  - Gateway of last resort: G1/0/24

## L3 Switch – 1

Device	Interface	IPv4 Address	IPv6 Address
S2	G1/0/24 (Routed)	10.16.1.2	2001:10:16:1::2/64
	G1/0/1-2 (Po1) {Layer 2}	trunk	trunk
	G1/0/3-4 (Po2) {Layer 2}	trunk	trunk
	G1/0/5-6 (Po3) {Layer 3}	10.16.3.12-13/24	2001:10:16:3::12-13/64

- **Interfaces**
  - All unused ports are placed in VLAN 222 and shutdown.
- **EtherChannel**
  - Provides fault-tolerance between switch block devices.
  - Channel Group
    - G1/0/1: Channel Group 1 – Mode: Desirable
    - G1/0/2: Channel Group 1 – Mode: Desirable
    - G1/0/3: Channel Group 2 – Mode: Auto
    - G1/0/4: Channel Group 2 – Mode: Auto
    - G1/0/5: Channel Group 3 – Mode: Passive
    - G1/0/6: Channel Group 3 – Mode: Passive
  - All EtherChannel interfaces are configure with the following.
    - Native VLAN: 333
    - Trunk Allowed: VLAN 10-15,222,333
- **Hot Standby Router Protocol (HSRP)**
  - L3 Switch – 2 is the passive router with a priority of 90 for all VLANS.
- **Routing**
  - OSPF is configured to detect networking devices.
    - Area: 16
    - Router ID 10.10.10.10
  - Gateway of last resort: G1/0/24

## **L2 Switch – 1**

- **Interfaces**
  - FA0/24 will be connected to a workstation with a VLAN 10 IP address.
  - All unused ports are placed in VLAN 222 and shutdown.
- **EtherChannel**
  - Provides fault-tolerance between switch block devices.
  - Channel Group
    - FA0/1: Channel Group 1 – Mode: Auto
    - FA0/2: Channel Group 1 – Mode: Auto
    - FA0/3: Channel Group 2 – Mode: Auto
    - FA0/4: Channel Group 2 – Mode: Auto
  - All EtherChannel interfaces are configure with the following.
    - Native VLAN: 333
    - Trunk Allowed: VLAN 10-15,222,333

# Routers

## R1 (Provider Edge)

Device	Interface	IPv4 Address	IPv6 Address
R1	G0/0/1	DHCP	
	G0/1/0 (Vlan 11)	198.18.1.254/24	2001:198:18:1::254/64
	G0/1/1 (Vlan 12)	198.18.2.254/24	2001:198:18:2::254/64
	G0/1/2 (Vlan 13)	198.18.3.254/24	2001:198:18:3::254/64
	G0/1/3 (Vlan 14)	198.18.4.254/24	2001:198:18:4::254/64

- **Interfaces**
  - G0/0/1: configured with DHCP and NAT to allow inbound and outbound internet traffic.
- **NAT**
  - VLAN 11-14: IP Nat Inside
- **Routing**
  - OSPF is configured to detect customer edge devices.
    - Router ID 1.1.1.1
    - Area 16
    - Default-Information Originate command is used to advertise the default routes into the OSPF routing domain.
  - Gateway of Last Resort: G0/0/1

## R2 to R5 (Customer Edge)

Device	Interface	IPv4 Address	IPv6 Address
R2	G0/0/0	198.18.3.1/24	2001:198:18:3::1/64
	G0/0/1 (Site 2)	10.16.100.1/24	2001:172:16:1::1/64
R3	G0/0/0	198.18.4.1/24	2001:198:18:5::1/64
	G0/0/1 (Site 3)	10.16.200.1/24	2001:172:16:2::1/64
R4	G0/0	198.18.1.1/24	2001:198:18:1::1/64
	G0/1 (Site 1)	10.16.1.254/24	2001:10:16:1::254/64
	S0/0/0	10.16.4.100/24	2001:10:16:4::100/64
R5	G0/0	198.18.2.1/24	2001:10:16:4::100/64
	G0/1 (Site 1)	10.16.2.254/24	2001:10:16:2::254/64
	S0/0/0	10.16.4.200/24	2001:10:16:4::200/64

- **Interfaces**
  - G0/0/1 used to connect to LAN portion of the site.
- **Dynamic Multipoint Virtual Private Network (DMVPN)**
  - Used to allow network traffic between customer edge routers through Provider Edge router.
    - R2: Hub Router
    - R3 to R5: Spoke Routers
    - Tunnel Source: G0/0/0
    - Tunnel Mode: GRE Multipoint
- **Routing**
  - OSPF is configured to detect customer edge devices.
    - Router ID 1.1.1.1
    - Area 16
    - Default-Information Originate command is used to advertise the default routes into the OSPF routing domain.
    - Advertises Provider Edge and Site-to-Site network.
      - 10.16.0.0
      - 198.18.0.0
  - Gateway of Last Resort
    - R2 to R3: G0/0/0
    - R4 to R5: G0/0
- **MPLS**
  - R2 to R3: configured on G0/0/0 and G0/0/1
  - R1 to R2: configured on G0/0 and G0/1

# Results

## Successful Implementations

### Layer 1

- Used VLAN 10 IP address on a Windows 11 machine to test network connectivity.

### Layer 2

- **VLAN Traffic**
  - o **MSTP**
    - Pinged PC to R2 and VLAN 10 traffic travelled through Switch 1.
    - Pinged PC to R2 and VLAN 30 traffic travelled through Switch 2.
- **EtherChannel**
  - o Shutdown port G1/0/5 from routed link (Port-Channel 3) and traced traffic from S1 to S2. S1 successfully reached S2.

### Layer 3

- **OSPF**
  - o OSPF route propagation and neighbour discovery worked across all routers.
  - o Pinged from all sites to each other, customer site to ISP, internet, and customer site to other customer sites.
- **DMVPN**
  - o Pinged through tunnels with R1 being the hub and remaining routers as spokes.
- **Routes**
  - o Default routes to ISP and floating static routes configured for HSRP.
- **HSRP**
  - o Shut down S1 and traffic was able to travel from PC to R2 site using VLAN 10 IP address.

### Layer 2 and Layer 3

- **MPLS**
  - o MPLS operational through traceroute pings. Each Customer Edge router was able to take the shortest route possible.

## **Needs Improvements**

- OSPF Broadcast to Multicast to allow faster convergence of OSPF neighbours.
- Did not perform a connection between R4 to R1. There is no redundant path going from R4 to R5 resulting in traffic being dropped when trying to reach R4.
  - o Solution: add a direct link between R4 to R5 using a serial link and use OSPF for floating static routes.
- HSRP operational but IP address for serial links not configured.