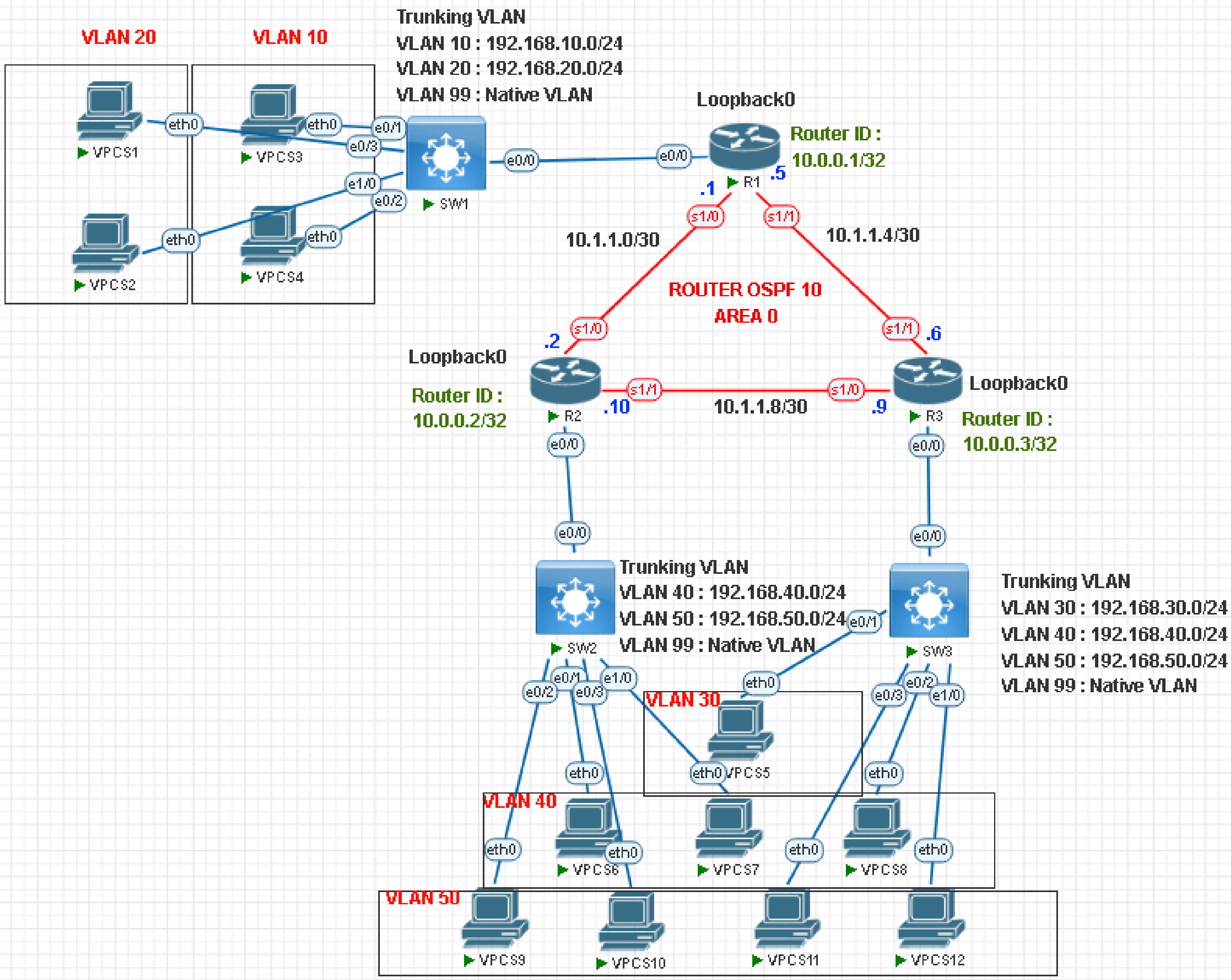
# Point-to-Point Single-Area OSPFv2





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# Link Addressing

| TABLE ADDRESSING | | | |
|---|---|---|---|
| **DEVICE** | **Interface** | **Ip Address** | **Default Gateway** |
| R1 | Loopback0 | 10.0.0.1/32 | NA |
| | S1/0 | 10.1.1.1/30 | NA |
| | S1/1 | 10.1.1.5/30 | NA |
| | E0/0.10 | 192.168.10.0/24 | NA |
| | E0/0.20 | 192.168.20.0/24 | NA |
| R2 | Loopback0 | 10.0.0.2/32 | NA |
| | S1/0 | 10.1.1.2/30 | NA |
| | S1/1 | 10.1.1.10/30 | NA |
| | E0/0.40 | 192.168.40.0/24 | NA |
| | E0/0.50 | 192.168.50.0/24 | NA |
| R3 | Loopback0 | 10.0.0.3/32 | NA |
| | S1/0 | 10.1.1.9/30 | NA |
| | S1/1 | 10.1.1.6/30 | NA |
| | E0/0.30 | 192.168.30.0/24 | NA |
| | E0/0.40 | 192.168.400.0/24 | NA |
| | E0/0.50 | 192.168.50.0/24 | NA |
| **DHCP SERVER** | | | |
| R1 | VLAN 10 | 192.168.10.0/24 | 192.168.10.1 |
| | VLAN 20 | 192.168.20.0/24 | 192.168.20.1 |
| R2 | VLAN 40 | 192.168.40.0/24 | 192.168.40.1 |
| | VLAN 50 | 192.168.50.0/24 | 192.168.50.1 |
| R3 | VLAN 30 | 192.168.30.0/24 | 192.168.30.1 |
| | VLAN 40 | 192.168.40.0/24 | 192.168.40.1 |
| | VLAN 50 | 192.168.50.0/24 | 192.168.50.1 |

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# Trunking VLAN In Switch

**Switch 1 (Trunk VLAN)**

```
SW1(config)#do show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Et0/0       on               802.1q         trunking      99

Port        Vlans allowed on trunk
Et0/0       10,20

Port        Vlans allowed and active in management domain
Et0/0       10,20

Port        Vlans in spanning tree forwarding state and not pruned
Et0/0       10,20
```

**Switch 2 (Trunk VLAN)**

```
SW2(config)#do show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Et0/0       on               802.1q         trunking      99

Port        Vlans allowed on trunk
Et0/0       40,50

Port        Vlans allowed and active in management domain
Et0/0       40,50

Port        Vlans in spanning tree forwarding state and not pruned
Et0/0       40,50
```

**Switch 3 (Trunk VLAN)**

```
SW3(config-if)#do show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Et0/0       on               802.1q         trunking      99

Port        Vlans allowed on trunk
Et0/0       30,40,50

Port        Vlans allowed and active in management domain
Et0/0       30,40,50

Port        Vlans in spanning tree forwarding state and not pruned
Et0/0       30,40,50
```

The configuration shows port on switch as a trunk using 802.1Q, a protocol for carrying traffic from multiple VLANs with tagging. The Native VLAN is set to VLAN 99 to handle untagged traffic, typically for compatibility or non-VLAN devices. The VLANs are active in the management domain and in the forwarding state in spanning tree, ensuring seamless communication without conflicts.

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# Configure DHCP Server

**Router 1 (DHCP Server Vlan 10,20)**

```
ip dhcp pool VLAN10
 network 192.168.10.0 255.255.255.0
 default-router 192.168.10.1
 dns-server 8.8.8.8
!
ip dhcp pool VLAN20
 network 192.168.20.0 255.255.255.0
 default-router 192.168.20.1
 dns-server 8.8.8.8
```

**Router 2 (DHCP Server Vlan 40,50)**

```
ip dhcp pool VLAN40
 network 192.168.40.0 255.255.255.0
 default-router 192.168.40.1
 dns-server 8.8.8.8
!
ip dhcp pool VLAN50
 network 192.168.50.0 255.255.255.0
 default-router 192.168.50.1
 dns-server 8.8.8.8
```

**Router 3 (DHCP Server Vlan 30,40,50)**

```
ip dhcp pool VLAN30
 network 192.168.30.0 255.255.255.0
 default-router 192.168.30.1
 dns-server 8.8.8.8
!
ip dhcp pool VLAN40
 network 192.168.40.0 255.255.255.0
 default-router 192.168.40.1
 dns-server 8.8.8.8
!
ip dhcp pool VLAN50
 network 192.168.50.0 255.255.255.0
 default-router 192.168.50.1
 dns-server 8.8.8.8
```

The **IP DHCP pool** configuration above is part of the DHCP Server function on a router, used to automatically assign IP addresses to client devices in the network. Each pool (VLAN10, VLAN20, VLAN30, VLAN40, VLAN50) defines the subnet network, **default gateway (default-router)**, and DNS server **(dns-server)** for clients within a specific VLAN. This simplifies network management by eliminating manual IP configuration, ensuring that each client receives the correct network settings for both local and internet access.

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# Configure OSPFv2

```
router ospf 10
 router-id 1.1.1.1
 network 10.0.0.1 0.0.0.0 area 0
 network 10.1.1.0 0.0.0.3 area 0
 network 10.1.1.4 0.0.0.3 area 0
 network 192.168.10.0 0.0.0.255 area 0
 network 192.168.20.0 0.0.0.255 area 0
```

**Router 1 (Network-Based Configuration)**

```
router ospf 10
 router-id 2.2.2.2
 network 10.0.0.2 0.0.0.0 area 0
 network 10.1.1.2 0.0.0.0 area 0
 network 10.1.1.9 0.0.0.0 area 0
 network 192.168.40.0 0.0.0.255 area 0
 network 192.168.50.0 0.0.0.0 area 0
 network 192.168.50.0 0.0.0.255 area 0
```

**Router 2 (Host-Specific Configuration)**

```
interface Loopback0
 ip address 10.0.0.3 255.255.255.255
 ip ospf 10 area 0
!
interface Ethernet0/0
 no ip address
 duplex auto
!
interface Ethernet0/0.30
 encapsulation dot1Q 30
 ip address 192.168.30.1 255.255.255.0
 ip ospf 10 area 0
!
interface Ethernet0/0.40
 encapsulation dot1Q 40
 ip address 192.168.40.1 255.255.255.0
 ip ospf 10 area 0
!
interface Ethernet0/0.50
 encapsulation dot1Q 50
 ip address 192.168.50.1 255.255.255.0
 ip ospf 10 area 0
!
```

```
interface Serial1/0
 description *** ROUTER3 TO ROUTER2 ***
 ip address 10.1.1.10 255.255.255.252
 ip ospf 10 area 0
 serial restart-delay 0
```

```
interface Serial1/1
 description *** ROUTER3 TO ROUTER1 ***
 ip address 10.1.1.6 255.255.255.252
 ip ospf 10 area 0
 serial restart-delay 0
!
```

```
router ospf 10
 router-id 3.3.3.3
```

**Router 3 Trunk (Interface-Based Configuration)**

The three configurations demonstrate **OSPFv2** methods: 1) The first router uses the network command with a **wildcard mask** to define subnets and OSPF areas. 2) The second router uses a **host-specific wildcard** mask (0.0.0.0) to advertise specific IPs, ideal for point-to-point links. 3) The third router enables OSPF directly on interfaces using ip ospf area, automatically advertising the connected subnets. All methods achieve OSPF functionality with different approaches.

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# Verifying OSPFv2

**Router 1**

```
R1(config-if)#do show ip ospf int brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               10.0.0.1/32        1     LOOP  0/0
Et0/0.20     10    0               192.168.20.1/24    10    DR    0/0
Et0/0.10     10    0               192.168.10.1/24    10    DR    0/0
Se1/1        10    0               10.1.1.5/30        64    P2P   0/0
Se1/0        10    0               10.1.1.1/30        64    P2P   1/1
```

**Router 2**

```
R2(config)#do show ip ospf int brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               10.0.0.2/32        1     LOOP  0/0
Et0/0.50     10    0               192.168.50.1/24    10    DR    0/0
Et0/0.40     10    0               192.168.40.1/24    10    DR    0/0
Se1/1        10    0               10.1.1.9/30        64    P2P   1/1
Se1/0        10    0               10.1.1.2/30        64    P2P   1/1
```

**Router 3**

```
R3(config-if)#do show ip ospf int brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          10    0               10.0.0.3/32        1     LOOP  0/0
Se1/1        10    0               10.1.1.6/30        64    P2P   1/1
Se1/0        10    0               10.1.1.10/30       64    P2P   1/1
Et0/0.50     10    0               192.168.50.1/24    10    DR    0/0
Et0/0.40     10    0               192.168.40.1/24    10    DR    0/0
Et0/0.30     10    0               192.168.30.1/24    10    DR    0/0
```

In the **OSPF interface brief output, Cos**t represents the OSPF metric for the interface, indicating the "expense" of using that interface in the path selection process, with lower values indicating more preferred routes (typically based on bandwidth).

**State** shows the current status of OSPF adjacencies, such as **LOOP** for loopback interfaces, **DR (Designated Router)** for the router selected as the DR in broadcast or non-broadcast multi-access networks, and **P2P (Point-to-Point)** for direct connections between two routers.

**Nbrs F/C** stands for **Neighbors/Full/Count**, where the first number shows the number of OSPF neighbors, **Full** indicates how many are in the Full state (fully established adjacencies), and **Count** displays the total number of neighbors, including those not fully established. These fields help monitor and troubleshoot OSPF interface performance and connectivity.

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# Table Routing OSPFv2

**Router 1**

```
     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O       10.0.0.2/32 [110/65] via 10.1.1.2, 01:38:21, Serial1/0
O       10.0.0.3/32 [110/65] via 10.1.1.6, 00:22:24, Serial1/1
O       10.1.1.8/30 [110/128] via 10.1.1.6, 00:22:24, Serial1/1
                    [110/128] via 10.1.1.2, 01:38:21, Serial1/0
O    192.168.30.0/24 [110/74] via 10.1.1.6, 00:22:24, Serial1/1
O    192.168.40.0/24 [110/74] via 10.1.1.6, 00:22:24, Serial1/1
                     [110/74] via 10.1.1.2, 01:38:21, Serial1/0
O    192.168.50.0/24 [110/74] via 10.1.1.6, 00:22:24, Serial1/1
                     [110/74] via 10.1.1.2, 01:38:21, Serial1/0
```

**Router 2**

```
     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O       10.0.0.1/32 [110/65] via 10.1.1.1, 01:39:06, Serial1/0
O       10.0.0.3/32 [110/65] via 10.1.1.10, 01:39:06, Serial1/1
O       10.1.1.4/30 [110/128] via 10.1.1.10, 00:23:09, Serial1/1
                    [110/128] via 10.1.1.1, 00:23:09, Serial1/0
O    192.168.10.0/24 [110/74] via 10.1.1.1, 01:39:06, Serial1/0
O    192.168.20.0/24 [110/74] via 10.1.1.1, 01:39:06, Serial1/0
O    192.168.30.0/24 [110/74] via 10.1.1.10, 01:39:06, Serial1/1
```

**Router 3**

```
     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O       10.0.0.1/32 [110/65] via 10.1.1.5, 00:21:53, Serial1/1
O       10.0.0.2/32 [110/65] via 10.1.1.9, 01:37:50, Serial1/0
O       10.1.1.0/30 [110/128] via 10.1.1.9, 01:37:50, Serial1/0
                    [110/128] via 10.1.1.5, 00:21:53, Serial1/1
O    192.168.10.0/24 [110/74] via 10.1.1.5, 00:21:53, Serial1/1
O    192.168.20.0/24 [110/74] via 10.1.1.5, 00:21:53, Serial1/1
```

The routing tables from Router 1, Router 2, and Router 3 show OSPF-learned routes **(O)**, indicating interconnectivity between the routers in a multi-area network. Each router lists networks it has learned, the metric (cost) to reach them, the **next-hop IP**, the **interface** used, and the **uptime** of each route. For example, Router 1 reaches **192.168.30.0/24** via **10.1.1.6** (Serial1/1) and **10.1.1.2** (Serial1/0), demonstrating redundancy with equal cost multipath. Similarly, each router has loopback addresses **(10.0.0.x/32)** and VLAN subnets reachable via other routers. These tables reflect a fully converged OSPF network with both point-to-point and broadcast links.

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# What Is Loopback?

**Router 1**

```
R1(config)#do show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                unassigned      YES manual up                    up
Ethernet0/0.10             192.168.10.1    YES NVRAM  up                    up
Ethernet0/0.20             192.168.20.1    YES NVRAM  up                    up
Ethernet0/1                unassigned      YES manual administratively down down
Ethernet0/2                unassigned      YES NVRAM  administratively down down
Ethernet0/3                unassigned      YES NVRAM  administratively down down
Serial1/0                  10.1.1.1        YES NVRAM  up                    up
Serial1/1                  10.1.1.5        YES NVRAM  up                    up
Serial1/2                  unassigned      YES NVRAM  administratively down down
Serial1/3                  unassigned      YES NVRAM  administratively down down
Loopback0                  10.0.0.1        YES manual up                    up
```

**Router 2**

```
R2(config)#do show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                unassigned      YES manual up                    up
Ethernet0/0.40             192.168.40.1    YES NVRAM  up                    up
Ethernet0/0.50             192.168.50.1    YES NVRAM  up                    up
Ethernet0/1                unassigned      YES NVRAM  administratively down down
Ethernet0/2                unassigned      YES NVRAM  administratively down down
Ethernet0/3                unassigned      YES NVRAM  administratively down down
Serial1/0                  10.1.1.2        YES NVRAM  up                    up
Serial1/1                  10.1.1.9        YES NVRAM  up                    up
Serial1/2                  unassigned      YES NVRAM  administratively down down
Serial1/3                  unassigned      YES NVRAM  administratively down down
Loopback0                  10.0.0.2        YES manual up                    up
```

**Router 3**

```
R3(config)#do show ip int brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                unassigned      YES manual up                    up
Ethernet0/0.30             192.168.30.1    YES NVRAM  up                    up
Ethernet0/0.40             192.168.40.1    YES NVRAM  up                    up
Ethernet0/0.50             192.168.50.1    YES NVRAM  up                    up
Ethernet0/1                unassigned      YES manual administratively down down
Ethernet0/2                unassigned      YES manual administratively down down
Ethernet0/3                unassigned      YES NVRAM  administratively down down
Serial1/0                  10.1.1.10       YES NVRAM  up                    up
Serial1/1                  10.1.1.6        YES NVRAM  up                    up
Serial1/2                  unassigned      YES NVRAM  administratively down down
Serial1/3                  unassigned      YES NVRAM  administratively down down
```

Loopback0 is a **virtual**, **logical interface on a router** that remains in an "up" state as long as the router is operational, regardless of physical interface status. It is commonly used in OSPF as a stable and unique **Router ID**, ensuring consistent identification even if physical interfaces go down. Additionally, it provides a reliable endpoint for management tasks like **SSH** and is useful for testing and diagnostics. For example, an IP address like **10.0.0.1/32** assigned to Loopback0 ensures continuous reachability of the router as long as it is running.

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# Test Ping & Traceroute Router To Router

```
R1(config)#do ping 10.1.1.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 7/8/10 ms
```

**Test Ping**
**Router 1 to Router 2**

```
R1(config)#do traceroute 10.1.1.10
Type escape sequence to abort.
Tracing the route to 10.1.1.10
VRF info: (vrf in name/id, vrf out name/id)
  1 10.1.1.6 9 msec
    10.1.1.2 9 msec
    10.1.1.6 8 msec
```

**Traceroute**
**Router 1 to Router 2**

```
R1(config)#do ping 10.1.1.9
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.9, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 9/9/10 ms
```

**Test Ping**
**Router 1 to Router 3**

```
R1(config)#do traceroute 10.1.1.9
Type escape sequence to abort.
Tracing the route to 10.1.1.9
VRF info: (vrf in name/id, vrf out name/id)
  1 10.1.1.2 10 msec
    10.1.1.6 9 msec
    10.1.1.2 8 msec
```

**Traceroute**
**Router 1 to Router 3**

The results show successful pings and traceroutes from Router 1 (R1) to various IP addresses in the network. When pinging **10.1.1.9** and **10.1.1.10**, the success rate is 100% with minimal round-trip times (7-10 ms). The traceroute to **10.1.1.9** shows that the path goes through **10.1.1.2** first (10ms), followed by **10.1.1.6** (9ms), and returns to **10.1.1.2** (8ms), confirming the route is stable. Similarly, the traceroute to **10.1.1.10** passes through **10.1.1.6** (9ms) and **10.1.1.2** (9ms), with a return to **10.1.1.6** (8ms), confirming the route is properly established and responsive. These tests indicate good network connectivity with minimal delays.

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# Test Ping VPCS to VPCS

```
VPCS> ping 192.168.20.3 -c 5

84 bytes from 192.168.20.3 icmp_seq=1 ttl=63 time=1.040 ms
84 bytes from 192.168.20.3 icmp_seq=2 ttl=63 time=1.170 ms
84 bytes from 192.168.20.3 icmp_seq=3 ttl=63 time=1.758 ms
84 bytes from 192.168.20.3 icmp_seq=4 ttl=63 time=0.856 ms
84 bytes from 192.168.20.3 icmp_seq=5 ttl=63 time=1.572 ms

VPCS> ping 192.168.30.2 -c 5

84 bytes from 192.168.30.2 icmp_seq=1 ttl=62 time=27.737 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=62 time=9.801 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=62 time=11.272 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=62 time=9.602 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=62 time=10.984 ms

VPCS> ping 192.168.40.2 -c 5

84 bytes from 192.168.40.2 icmp_seq=1 ttl=62 time=12.625 ms
84 bytes from 192.168.40.2 icmp_seq=2 ttl=62 time=10.288 ms
84 bytes from 192.168.40.2 icmp_seq=3 ttl=62 time=10.359 ms
84 bytes from 192.168.40.2 icmp_seq=4 ttl=62 time=10.259 ms
84 bytes from 192.168.40.2 icmp_seq=5 ttl=62 time=10.904 ms

VPCS> ping 192.168.50.3 -c 5

84 bytes from 192.168.50.3 icmp_seq=1 ttl=62 time=18.824 ms
84 bytes from 192.168.50.3 icmp_seq=2 ttl=62 time=10.699 ms
84 bytes from 192.168.50.3 icmp_seq=3 ttl=62 time=10.878 ms
84 bytes from 192.168.50.3 icmp_seq=4 ttl=62 time=10.955 ms
84 bytes from 192.168.50.3 icmp_seq=5 ttl=62 time=11.301 ms
```

**Test Ping VPCS (VLAN 10) to VPCS (VLAN 20,30,40,50)**

The ping results show that the VPCS device successfully reached all target IP addresses (192.168.20.3, 192.168.30.2, 192.168.40.2, and 192.168.50.3) with a 100% success rate and varying response times. The ping to **192.168.20.3** had an average response time of around 1 ms, indicating low latency. The pings to **192.168.30.2** and **192.168.40.2** had slightly higher response times, ranging from 9 ms to 27 ms, while the ping to **192.168.50.3** showed latencies between 10 ms and 18 ms. This indicates that all devices in the network are able to communicate successfully, with some differences in latency between them.

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