**Experiment 08**

**VLAN Configuration Using eNSP**

## 8.1 Objectives

The main objectives of this experiment are

- To set up a simple network topology using eNSP software.
- To configure OSPF routing protocol on the routers.
- To configure VLAN routing protocol on the switches.

## 8.2 Theory

VLAN configuration refers to the process of setting up and managing Virtual Local Area Networks (VLANs) on network devices, such as switches or routers. VLANs are used to logically segment a physical network into multiple virtual networks, allowing you to isolate and control the flow of traffic between different groups of devices.

The primary purpose of VLANs is to improve network performance, security, and management by creating separate broadcast domains. Devices within the same VLAN can communicate with each other as if they are connected to the same physical network, even if they are physically located on different switches or network segments.

## 8.3 Required Apparatus

1. eNSP (Enterprise Network Simulation Platform) Software
2. A highly configured PC

## 8.4 Topology Diagram

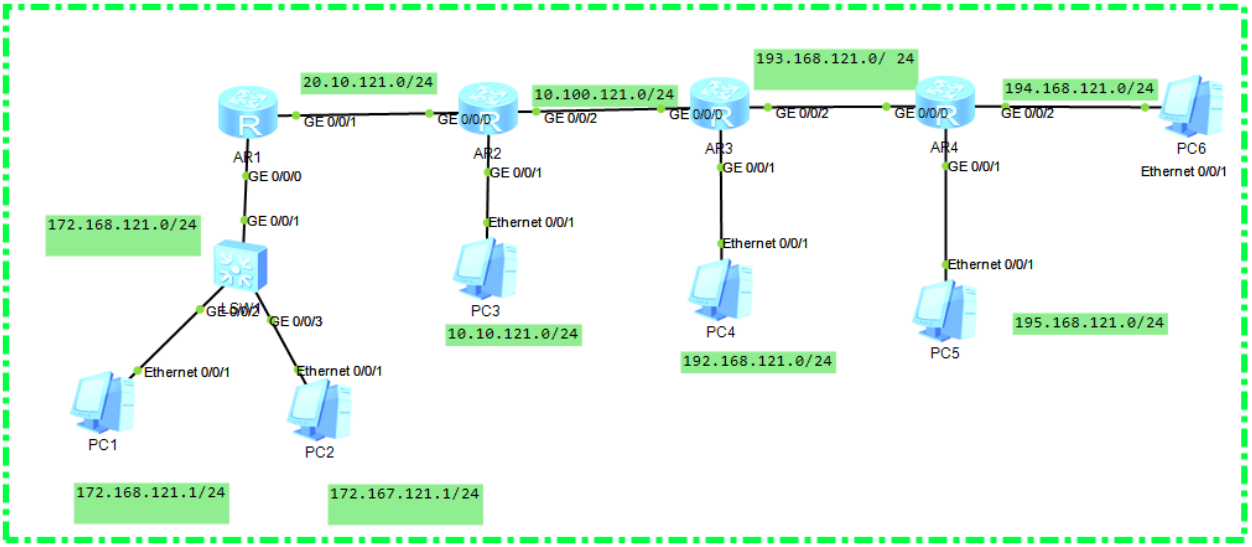


Figure 8.1: Basic Topology Diagram of OSPF Routing

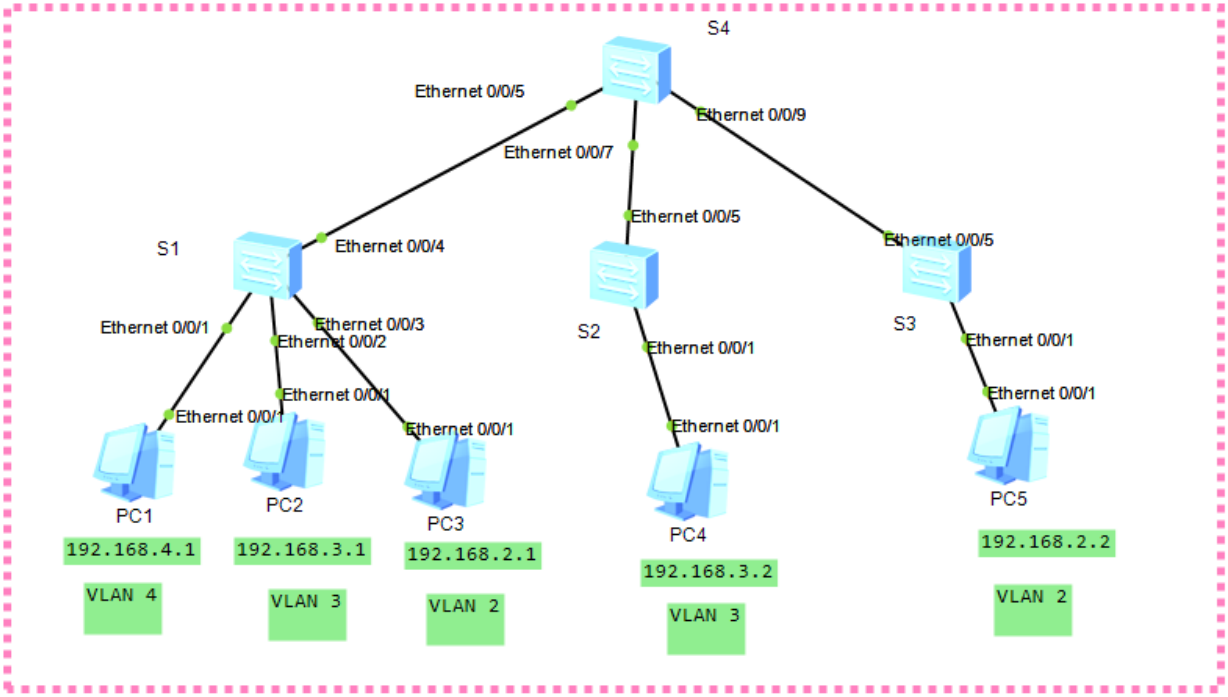


Figure 8.2: Basic Topology Diagram of VLAN Routing

## 8.5 Configuration

### 8.5.1 OSPF Routing

**IP Address Assignment:**

```
The number of interface that is UP in Physical is 3
The number of interface that is DOWN in Physical is 1
The number of interface that is UP in Protocol is 3
The number of interface that is DOWN in Protocol is 1

Interface                         IP Address/Mask      Physical   Protocol
GigabitEthernet0/0/0              172.168.121.254/24   up         up
GigabitEthernet0/0/1              20.10.121.1/24       up         up
GigabitEthernet0/0/2              unassigned           down       down
NULL0                             unassigned           up         up(s)
[AR1]di
```

Figure 8.3: IP Addresses for Router 1

```
The number of interface that is UP in Physical is 4
The number of interface that is DOWN in Physical is 0
The number of interface that is UP in Protocol is 4
The number of interface that is DOWN in Protocol is 0

Interface                         IP Address/Mask      Physical   Protocol
GigabitEthernet0/0/0              20.10.121.2/24       up         up
GigabitEthernet0/0/1              10.10.121.254/24     up         up
GigabitEthernet0/0/2              10.100.121.2/24      up         up
NULL0                             unassigned           up         up(s)
[AR2]
```

Figure 8.4: IP Addresses for Router 2

```
The number of interface that is UP in Physical is 4
The number of interface that is DOWN in Physical is 0
The number of interface that is UP in Protocol is 4
The number of interface that is DOWN in Protocol is 0

Interface                         IP Address/Mask      Physical   Protocol
GigabitEthernet0/0/0              10.100.121.3/24      up         up
GigabitEthernet0/0/1              192.168.121.254/24   up         up
GigabitEthernet0/0/2              193.168.121.3/24     up         up
NULL0                             unassigned           up         up(s)
<AR3>
```

Figure 8.5: IP Addresses for Router 3

```
The number of interface that is UP in Physical is 4
The number of interface that is DOWN in Physical is 0
The number of interface that is UP in Protocol is 4
The number of interface that is DOWN in Protocol is 0

Interface                         IP Address/Mask      Physical   Protocol
GigabitEthernet0/0/0              193.168.121.4/24     up         up
GigabitEthernet0/0/1              195.168.121.254/24   up         up
GigabitEthernet0/0/2              194.168.121.254/24   up         up
NULL0                             unassigned           up         up(s)
<AR4>
```

Figure 8.6: IP Addresses for Router 4

**PC Configuration:**

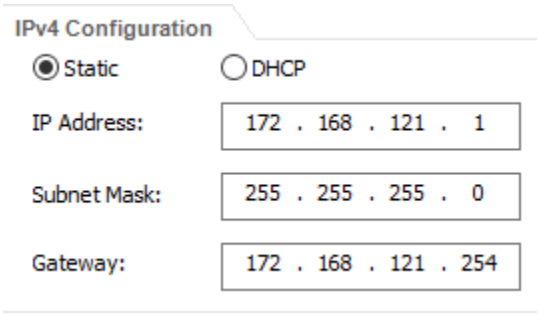


Figure 8.7: PC configuration for PC 1

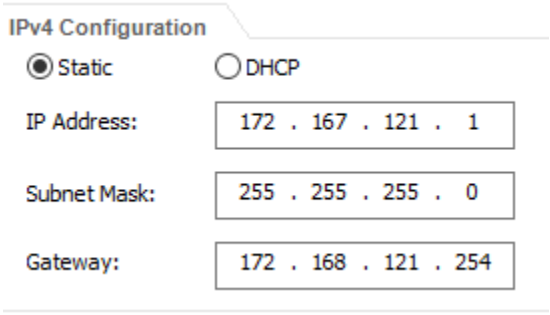


Figure 8.8: PC configuration for PC 2

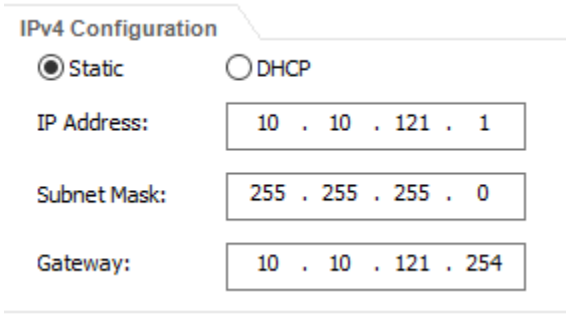


Figure 8.9: PC configuration for PC 3

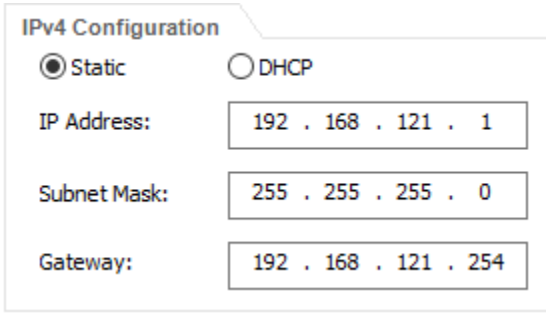


Figure 8.10: PC configuration for PC 4

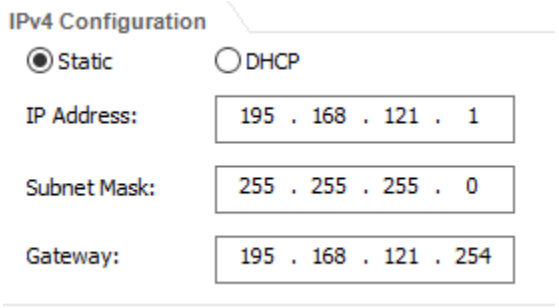


Figure 8.11: PC configuration for PC 5

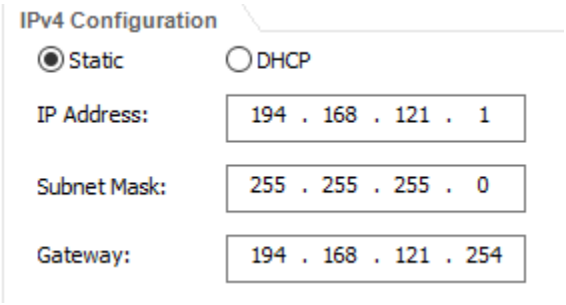


Figure 8.12: PC configuration for PC 6

**Routing Tables :**

```
[AR1]display ospf routing

      OSPF Process 1 with Router ID 172.168.121.254
             Routing Tables

Routing for Network
Destination        Cost  Type       NextHop         AdvRouter       Area
20.10.121.0/24     1     Transit    20.10.121.1     172.168.121.254 0.0.0.0
172.168.121.0/24   1     Stub       172.168.121.254 172.168.121.254 0.0.0.0
10.10.121.0/24     2     Stub       20.10.121.2     20.10.121.2     0.0.0.0
10.100.121.0/24    2     Transit    20.10.121.2     20.10.121.2     0.0.0.0
192.168.121.0/24   3     Stub       20.10.121.2     10.100.121.3    0.0.0.0
193.168.121.0/24   3     Transit    20.10.121.2     193.168.121.4   0.0.0.0
194.168.121.0/24   4     Stub       20.10.121.2     193.168.121.4   0.0.0.0
195.168.121.0/24   4     Stub       20.10.121.2     193.168.121.4   0.0.0.0

Total Nets: 8
Intra Area: 8  Inter Area: 0  ASE: 0  NSSA: 0

[AR1]
```

Figure 8.13: OSPF Routing Table for Router 1

```
[AR2]display ospf routing

      OSPF Process 1 with Router ID 20.10.121.2
            Routing Tables

Routing for Network
Destination        Cost  Type       NextHop         AdvRouter       Area
10.10.121.0/24     1     Stub       10.10.121.254   20.10.121.2     0.0.0.0
10.100.121.0/24    1     Transit    10.100.121.2    20.10.121.2     0.0.0.0
20.10.121.0/24     1     Transit    20.10.121.2     20.10.121.2     0.0.0.0
172.168.121.0/24   2     Stub       20.10.121.1     172.168.121.254 0.0.0.0
192.168.121.0/24   2     Stub       10.100.121.3    10.100.121.3    0.0.0.0
193.168.121.0/24   2     Transit    10.100.121.3    193.168.121.4   0.0.0.0
194.168.121.0/24   3     Stub       10.100.121.3    193.168.121.4   0.0.0.0
195.168.121.0/24   3     Stub       10.100.121.3    193.168.121.4   0.0.0.0

Total Nets: 8
Intra Area: 8  Inter Area: 0  ASE: 0  NSSA: 0
```

Figure 8.14: OSPF Routing Table for Router 2

```
<AR3>display ospf routing

      OSPF Process 1 with Router ID 10.100.121.3
            Routing Tables

Routing for Network
Destination        Cost  Type       NextHop         AdvRouter       Area
10.100.121.0/24    1     Transit    10.100.121.3    10.100.121.3    0.0.0.0
192.168.121.0/24   1     Stub       192.168.121.254 10.100.121.3    0.0.0.0
193.168.121.0/24   1     Transit    193.168.121.3   10.100.121.3    0.0.0.0
10.10.121.0/24     2     Stub       10.100.121.2    20.10.121.2     0.0.0.0
20.10.121.0/24     2     Transit    10.100.121.2    172.168.121.254 0.0.0.0
172.168.121.0/24   3     Stub       10.100.121.2    172.168.121.254 0.0.0.0
194.168.121.0/24   2     Stub       193.168.121.4   193.168.121.4   0.0.0.0
195.168.121.0/24   2     Stub       193.168.121.4   193.168.121.4   0.0.0.0

Total Nets: 8
Intra Area: 8  Inter Area: 0  ASE: 0  NSSA: 0
```

Figure 8.15: OSPF Routing Table for Router 3

```
<AR4>display ospf routing

      OSPF Process 1 with Router ID 193.168.121.4
             Routing Tables

Routing for Network
Destination        Cost  Type       NextHop         AdvRouter       Area
193.168.121.0/24   1     Transit    193.168.121.4   193.168.121.4   0.0.0.0
194.168.121.0/24   1     Stub       194.168.121.254 193.168.121.4   0.0.0.0
195.168.121.0/24   1     Stub       195.168.121.254 193.168.121.4   0.0.0.0
10.10.121.0/24     3     Stub       193.168.121.3   20.10.121.2     0.0.0.0
10.100.121.0/24    2     Transit    193.168.121.3   20.10.121.2     0.0.0.0
20.10.121.0/24     3     Transit    193.168.121.3   172.168.121.254 0.0.0.0
172.168.121.0/24   4     Stub       193.168.121.3   172.168.121.254 0.0.0.0
192.168.121.0/24   2     Stub       193.168.121.3   10.100.121.3    0.0.0.0

Total Nets: 8
Intra Area: 8  Inter Area: 0  ASE: 0  NSSA: 0
```

Figure 8.16: OSPF Routing Table for Router 4

The summary at the bottom of the routing table provides information about the number of networks (Total Nets) and the distribution of those networks in different OSPF areas. In this case, all networks are within the same area (Area 0.0.0.0), so there are 8 intra-area routes and 0 inter-area routes. There are no Autonomous System External (ASE) routes or Not-So-Stubby-Area (NSSA) routes in this routing table.

### 8.5.2 VLAN Routing

**Defining VLAN:**

```
[S1]vlan 2
[S1-vlan2]
```

Figure 8.17: Defining VLAN in System

As figure 8.17, VLAN 2, 3 and 4 were defined in switch 1, switch 2 and switch 3.

```
[S1]interface ethernet 0/0/3
[S1-Ethernet0/0/3]port link-ty
[S1-Ethernet0/0/3]port link-type access
[S1-Ethernet0/0/3]port default vlan 2
```

Figure 8.18: Defining port in Ethernet of Switch

As fig 8.18, ports were defined in Ethernet cable.

```
[S1]interface ethernet 0/0/4
[S1-Ethernet0/0/4]port link
[S1-Ethernet0/0/4]port link-type trunk
[S1-Ethernet0/0/4]port tr
[S1-Ethernet0/0/4]port trunk all
[S1-Ethernet0/0/4]port trunk allow-pass v
[S1-Ethernet0/0/4]port trunk allow-pass vlan all
[S1-Ethernet0/0/4]
```

Figure 8.18: Connection with master switch

**VLAN Routing Tables:**

```
<S1>sys
Enter system view, return user view with Ctrl+Z.
[S1]dis vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;         D: Down;         TG: Tagged;         UT: Untagged;
MP: Vlan-mapping;               ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/4(U)     Eth0/0/5(D)     Eth0/0/6(D)     Eth0/0/7(D)
                Eth0/0/8(D)     Eth0/0/9(D)     Eth0/0/10(D)    Eth0/0/11(D)
                Eth0/0/12(D)    Eth0/0/13(D)    Eth0/0/14(D)    Eth0/0/15(D)
                Eth0/0/16(D)    Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)
                Eth0/0/20(D)    Eth0/0/21(D)    Eth0/0/22(D)    GE0/0/1(D)
                GE0/0/2(D)

2    common  UT:Eth0/0/3(U)
             TG:Eth0/0/4(U)

3    common  UT:Eth0/0/2(U)

             TG:Eth0/0/4(U)

4    common  UT:Eth0/0/1(U)

             TG:Eth0/0/4(U)


VID  Status  Property      MAC-LRN Statistics Description
--------------------------------------------------------------------------------

1    enable  default       enable  disable    VLAN 0001
2    enable  default       enable  disable    VLAN 0002
3    enable  default       enable  disable    VLAN 0003
4    enable  default       enable  disable    VLAN 0004
[S1]
```

Figure 8.19: VLAN Table for Switch 1

From fig. 8.19 the total number of VLANs is 4. VLAN Configuration Details:

1. VLAN ID: 1
    - Type: Common
    - Ports: Eth0/0/4 (Untagged), Eth0/0/5 to Eth0/0/22, GE0/0/1, GE0/0/2 (All Down)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0001
2. VLAN ID: 2
    - Type: Common
    - Ports: Eth0/0/3 (Untagged), Eth0/0/4 (Tagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0002
3. VLAN ID: 3
    - Type: Common
    - Ports: Eth0/0/2 (Untagged), Eth0/0/4 (Tagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0003
4. VLAN ID: 4
    - Type: Common
    - Ports: Eth0/0/1 (Untagged), Eth0/0/4 (Tagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0004

```
<S2>sys
Enter system view, return user view with Ctrl+Z.
[S2]dis vlan
The total number of vlans is : 2
--------------------------------------------------------------------------------
U: Up;         D: Down;         TG: Tagged;         UT: Untagged;
MP: Vlan-mapping;               ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)     Eth0/0/5(U)
                Eth0/0/6(D)     Eth0/0/7(D)     Eth0/0/8(D)     Eth0/0/9(D)
                Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)    Eth0/0/13(D)
                Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)    Eth0/0/17(D)
                Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)    Eth0/0/21(D)
                Eth0/0/22(D)    GE0/0/1(D)      GE0/0/2(D)

3    common  UT:Eth0/0/1(U)
             TG:Eth0/0/5(U)


VID  Status  Property      MAC-LRN Statistics Description
--------------------------------------------------------------------------------
1    enable  default       enable  disable    VLAN 0001
3    enable  default       enable  disable    VLAN 0003
[S2]
[S2]
```

Figure 8.20 : VLAN table for Switch 2

From Figure 8.20- the total number of VLANs is 2.

VLAN Configuration Details:

1. VLAN ID: 1
    - Type: Common
    - Ports: Eth0/0/2 to Eth0/0/22, GE0/0/1, GE0/0/2 (All Down), Eth0/0/5 (Untagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0001
2. VLAN ID: 3
    - Type: Common
    - Ports: Eth0/0/1 (Untagged), Eth0/0/5 (Tagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0003

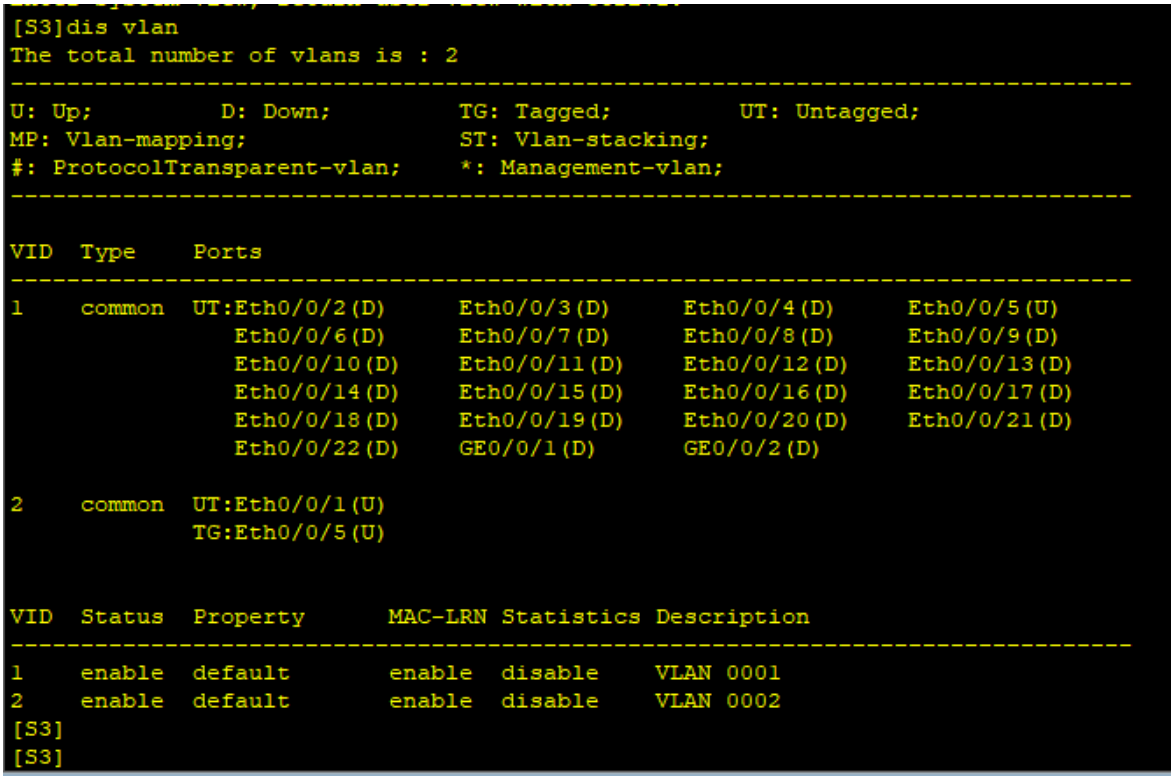


Figure 8.21 :VLAN table for switch 3

VLAN Configuration Details:

1. VLAN ID: 1
    - Type: Common
    - Ports: Eth0/0/2 to Eth0/0/22, GE0/0/1, GE0/0/2 (All Down), Eth0/0/5 (Untagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0001
2. VLAN ID: 2
    - Type: Common
    - Ports: Eth0/0/1 (Untagged), Eth0/0/5 (Tagged)
    - Status: Enabled
    - Property: Default
    - MAC Learning: Enabled
    - Statistics: Disabled
    - Description: VLAN 0002

```
<S4>sys
Enter system view, return user view with Ctrl+Z.
[S4]dis vlan
The total number of vlans is : 4
--------------------------------------------------------------------------------
U: Up;         D: Down;         TG: Tagged;         UT: Untagged;
MP: Vlan-mapping;               ST: Vlan-stacking;
#: ProtocolTransparent-vlan;    *: Management-vlan;
--------------------------------------------------------------------------------

VID  Type    Ports
--------------------------------------------------------------------------------
1    common  UT:Eth0/0/1(D)     Eth0/0/2(D)     Eth0/0/3(D)     Eth0/0/4(D)
                Eth0/0/5(U)     Eth0/0/6(D)     Eth0/0/7(U)     Eth0/0/8(D)
                Eth0/0/9(U)     Eth0/0/10(D)    Eth0/0/11(D)    Eth0/0/12(D)
                Eth0/0/13(D)    Eth0/0/14(D)    Eth0/0/15(D)    Eth0/0/16(D)
                Eth0/0/17(D)    Eth0/0/18(D)    Eth0/0/19(D)    Eth0/0/20(D)
                Eth0/0/21(D)    Eth0/0/22(D)    GE0/0/1(D)      GE0/0/2(D)

2    common  TG:Eth0/0/5(U)     Eth0/0/7(U)     Eth0/0/9(U)

3    common  TG:Eth0/0/5(U)     Eth0/0/7(U)     Eth0/0/9(U)

4    common  TG:Eth0/0/5(U)     Eth0/0/7(U)     Eth0/0/9(U)


VID  Status  Property      MAC-LRN Statistics Description
--------------------------------------------------------------------------------

1    enable  default       enable  disable    VLAN 0001
2    enable  default       enable  disable    VLAN 0002
3    enable  default       enable  disable    VLAN 0003
4    enable  default       enable  disable    VLAN 0004
[S4]
[S4]
```

Figure 8.22: V:LAN table for master switch 4

VLANs are used to logically segregate network traffic. Devices within the same VLAN can communicate with each other directly, while devices in different VLANs typically require routing through a Layer 3 device (like a router) to communicate. Each VLAN is identified by a VLAN ID (VID).Ports are associated with each VLAN, and they can be either tagged (TG) or untagged (UT) on specific VLANs."UT:Eth0/0/x(U)" means port Eth0/0/x is untagged on the respective VLAN."TG:Eth0/0/x(U)" means port Eth0/0/x is tagged on the respective VLAN.

## 8.6 Result

The results obtained from the testing phase showed the following:

### 8.6.1 OSPF Routing

The ping from PC1 to PC5 had a response time of 46/53/63 ms.

```
PC>ping 195.168.121.1

Ping 195.168.121.1: 32 data bytes, Press Ctrl_C to break
From 195.168.121.1: bytes=32 seq=1 ttl=124 time=46 ms
From 195.168.121.1: bytes=32 seq=2 ttl=124 time=47 ms
From 195.168.121.1: bytes=32 seq=3 ttl=124 time=62 ms
From 195.168.121.1: bytes=32 seq=4 ttl=124 time=47 ms
From 195.168.121.1: bytes=32 seq=5 ttl=124 time=63 ms

--- 195.168.121.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 46/53/63 ms
```

Figure 8.23: Pinging from PC1 to PC5

```
PC>ping 194.168.121.1

Ping 194.168.121.1: 32 data bytes, Press Ctrl_C to break
From 194.168.121.1: bytes=32 seq=1 ttl=125 time=32 ms
From 194.168.121.1: bytes=32 seq=2 ttl=125 time=31 ms
From 194.168.121.1: bytes=32 seq=3 ttl=125 time=31 ms
From 194.168.121.1: bytes=32 seq=4 ttl=125 time=31 ms
From 194.168.121.1: bytes=32 seq=5 ttl=125 time=32 ms

--- 194.168.121.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 31/31/32 ms
```

Figure 8.24: Pinging from PC3 to PC6

### 8.6.2 VLAN Routing

The ping from PC 1 to PC 5 -

```
PC>ping 192.168.2.2

Ping 192.168.2.2: 32 data bytes, Press Ctrl_C to break
From 192.168.2.2: bytes=32 seq=1 ttl=127 time=125 ms
From 192.168.2.2: bytes=32 seq=2 ttl=127 time=94 ms
From 192.168.2.2: bytes=32 seq=3 ttl=127 time=110 ms
From 192.168.2.2: bytes=32 seq=4 ttl=127 time=109 ms
From 192.168.2.2: bytes=32 seq=5 ttl=127 time=94 ms

--- 192.168.2.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 94/106/125 ms
```

Figure 8.25: Pinging from PC1 to PC 5

The ping from PC 2 to PC 4 -

```
PC>ping 192.168.3.2

Ping 192.168.3.2: 32 data bytes, Press Ctrl_C to
break
From 192.168.3.2: bytes=32 seq=1 ttl=128 time=94 ms
From 192.168.3.2: bytes=32 seq=2 ttl=128 time=109 ms
From 192.168.3.2: bytes=32 seq=3 ttl=128 time=94 ms
From 192.168.3.2: bytes=32 seq=4 ttl=128 time=78 ms
From 192.168.3.2: bytes=32 seq=5 ttl=128 time=78 ms

--- 192.168.3.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 78/90/109 ms
```

Figure 8.26: Pinging from PC 2 to PC 4

## 8.7 Discussion and Conclusion

The primary purpose of VLANs is to improve network performance, security, and management by creating separate broadcast domains, To enable communication between devices in different VLANs, inter-VLAN routing was set up. This achieved through a Layer 3 switch. Each VLAN is identified by a unique VLAN ID, often referred to as the VID. The VID helps the network devices distinguish one VLAN from another. Network ports on a switch can be assigned to specific VLANs. Ports can be either "Untagged" (access ports) or "Tagged" (trunk ports) for a particular VLAN. Devices connected to untagged ports become members of the associated VLAN automatically. Trunk ports are used to carry traffic for multiple VLANs and are typically used to interconnect switches. VLAN configuration is crucial for creating a flexible and efficient network that addresses the unique requirements of different departments, applications, or security zones within an organization. Properly configured VLANs can enhance network performance, provide better security, and simplify network management.