Lab 07

Phase 1 — Enterprise Foundation

Lab 07 — Inter-VLAN Routing & Gateway Design

Section A — Enterprise Build Scenario

Lab Type

Enterprise Foundation Build Lab

Difficulty

Intermediate

Estimated Time

150–180 Minutes

Lab Objective

In this lab, you will deploy enterprise inter-VLAN routing using a Layer 3 gateway design.

You will learn how to:

- configure router-on-a-stick operations,
- deploy 802.1Q subinterfaces,
- enable inter-VLAN communication,

- validate enterprise gateway operations,
- troubleshoot VLAN routing failures,
- and implement scalable enterprise Layer 3 segmentation.

Why This Lab Matters

Enterprise networks require communication between departments while maintaining VLAN segmentation.

Without inter-VLAN routing:

- VLANs remain isolated,
- enterprise applications fail,
- services become unreachable,
- and network operations become fragmented.

Modern enterprise networks rely heavily on:

- Layer 3 gateway design,
- VLAN segmentation,
- scalable routing,
- and predictable traffic flow.

This lab introduces the operational workflow used in enterprise campus routing environments.

Enterprise Scenario

Your organization has deployed enterprise VLAN segmentation for:

- Sales,
- Engineering,
- and Management.

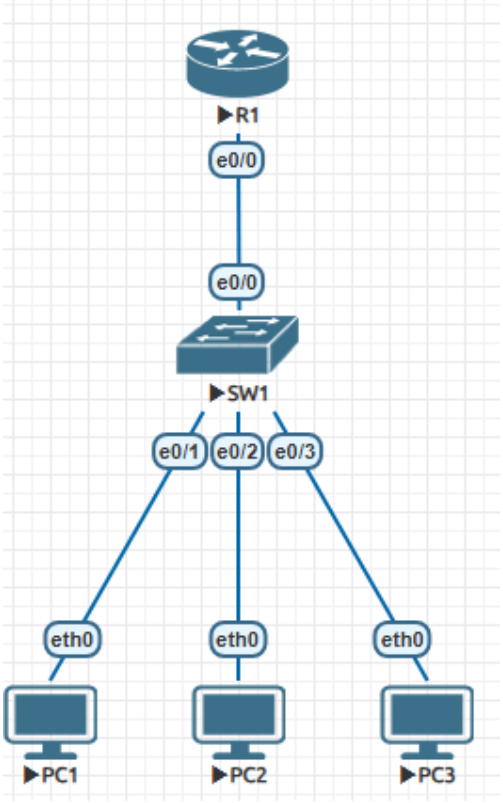
Management now requires communication between VLANs for:

- shared applications,
- centralized services,

- enterprise management systems,
- and internal collaboration.

You are assigned to deploy enterprise inter-VLAN routing using router-on-a-stick architecture.

Topology for EVE-NG & GNS3



Connection Table

Device	Interface	Connected To	Interface
R1	Ethernet0/0	SW1	Ethernet0/0
SW1	Ethernet0/1	PC1	eth0
SW1	Ethernet0/2	PC2	eth0
SW1	Ethernet0/3	PC3	eth0

VLAN Design Table

VLAN ID	VLAN Name
10	SALES
20	ENGINEERING
99	MANAGEMENT

IP Addressing Table

Device	Interface	IP Address	Gateway
PC1	eth0	10.10.10.10/24	10.10.10.1
PC2	eth0	10.20.20.10/24	10.20.20.1
PC3	eth0	10.99.99.10/24	10.99.99.1

Enterprise Naming Standards

Device Type	Naming Convention
Enterprise Router	R1
Enterprise Switch	SW1
Sales Endpoint	PC1
Engineering Endpoint	PC2
Management Endpoint	PC3

Required Images

Device	Purpose
Cisco Catalyst 8000V	Enterprise routing
Cisco IOLL2	Enterprise switching
VPCS	Endpoint validation

Step 1 — Deploy Nodes in EVE-NG

Goal

Deploy the enterprise inter-VLAN routing topology.

Add The Following Nodes

Node	Quantity
C8000v Router	1
IOLL2 Switch	1
VPCS Host	3

Step 2 — Connect The Enterprise Topology

Goal

Create all enterprise topology connections.

Use the Connection Table above.

Step 3 — Configure VPCS Hosts

PC1

```
VPCS> ip 10.10.10.10/24 10.10.10.1
Checking for duplicate address...
VPCS : 10.10.10.10 255.255.255.0 gateway 10.10.10.1

VPCS> set pcname PC1

PC1> save
Saving startup configuration to startup.vpc
.  done
```

PC2

```
ip 10.20.20.10/24 10.20.20.1
set pcname PC2
save
```

PC3

```
ip 10.99.99.10/24 10.99.99.1
set pcname PC3
save
```

Verification

```
PC1> show ip

NAME        : PC1[1]
IP/MASK     : 10.10.10.10/24
GATEWAY     : 10.10.10.1
DNS         :
MAC         : 00:50:79:66:68:04
LPORT       : 20000
RHOST:PORT  : 127.0.0.1:30000
MTU         : 1500
```

Expected Result

All endpoints should display:

- correct IP addressing,
- correct default gateways,
- operational interface state.

Step 4 — Configure SW1 VLANs

Goal

Deploy enterprise VLAN segmentation.

Commands

```
enable
conf t

hostname SW1

vlan 10
 name SALES

vlan 20
 name ENGINEERING

vlan 99
 name MANAGEMENT

interface Ethernet0/1
 switchport mode access
 switchport access vlan 10
 spanning-tree portfast
 no shutdown

interface Ethernet0/2
 switchport mode access
 switchport access vlan 20
 spanning-tree portfast
 no shutdown

interface Ethernet0/3
 switchport mode access
 switchport access vlan 99
 spanning-tree portfast
 no shutdown

interface Ethernet0/0
 switchport trunk encapsulation dot1q
 switchport mode trunk
 switchport trunk native vlan 99
 switchport trunk allowed vlan 10,20,99
 no shutdown

end
write memory
```

Verification

```
SW1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active
10   SALES                            active    Et0/1
20   ENGINEERING                      active    Et0/2
99   MANAGEMENT                       active    Et0/3
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

```
SW1#show interfaces trunk

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

Port           Vlans allowed on trunk
Et0/0          10,20,99

Port           Vlans allowed and active in management domai
n
Et0/0          10,20,99

Port           Vlans in spanning tree forwarding state and
not pruned
Et0/0          none
```

Expected Result

- VLANs should appear active
- Access ports should map correctly
- Trunk should operate successfully

Step 5 — Configure R1 Router-on-a-Stick

Goal

Deploy enterprise inter-VLAN routing.

Commands

```
enable
conf t

hostname R1

interface Ethernet0/0
 no shutdown

interface Ethernet0/0.10
 encapsulation dot1Q 10
 ip address 10.10.10.1 255.255.255.0

interface Ethernet0/0.20
 encapsulation dot1Q 20
 ip address 10.20.20.1 255.255.255.0

interface Ethernet0/0.99
 encapsulation dot1Q 99 native
 ip address 10.99.99.1 255.255.255.0

end
write memory
```

Verification

```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            unassigned      YES unset  up                    up
Ethernet0/0.10         10.10.10.1      YES manual up                    up
Ethernet0/0.20         10.20.20.1      YES manual up                    up
Ethernet0/0.99         10.99.99.1      YES manual up                    up
Ethernet0/1            unassigned      YES unset  administratively down down
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
```

```
R1#show running-config interface Ethernet0/0.10
Building configuration...

Current configuration : 93 bytes
!
interface Ethernet0/0.10
 encapsulation dot1Q 10
 ip address 10.10.10.1 255.255.255.0
end

R1#show running-config interface Ethernet0/0.20
Building configuration...

Current configuration : 93 bytes
!
interface Ethernet0/0.20
 encapsulation dot1Q 20
 ip address 10.20.20.1 255.255.255.0
end

R1#show running-config interface Ethernet0/0.99
Building configuration...

Current configuration : 100 bytes
!
interface Ethernet0/0.99
 encapsulation dot1Q 99 native
 ip address 10.99.99.1 255.255.255.0
end
```

Expected Result

- All subinterfaces should appear UP/UP
- VLAN encapsulation should operate correctly
- Gateway IPs should be reachable

Step 6 — Validate Inter-VLAN Connectivity

Goal

Validate enterprise Layer 3 communication.

From PC1

```
PC1> ping 10.20.20.10

84 bytes from 10.20.20.10 icmp_seq=1 ttl=63 time=2.540 ms
84 bytes from 10.20.20.10 icmp_seq=2 ttl=63 time=1.798 ms
84 bytes from 10.20.20.10 icmp_seq=3 ttl=63 time=1.657 ms
```

Expected Result

PC2 should respond successfully.

From PC1

```
PC1> ping 10.99.99.10

84 bytes from 10.99.99.10 icmp_seq=1 ttl=63 time=2.701 ms
84 bytes from 10.99.99.10 icmp_seq=2 ttl=63 time=2.670 ms
84 bytes from 10.99.99.10 icmp_seq=3 ttl=63 time=2.930 ms
```

Expected Result

PC3 should respond successfully.

Step 7 — Validate Gateway Reachability

Goal

Validate enterprise gateway operations.

From PC2

```
PC2> ping 10.20.20.1

84 bytes from 10.20.20.1 icmp_seq=1 ttl=255 time=0.939 ms
84 bytes from 10.20.20.1 icmp_seq=2 ttl=255 time=0.934 ms
84 bytes from 10.20.20.1 icmp_seq=3 ttl=255 time=1.029 ms
```

Expected Result

Gateway should respond successfully.

From PC3

```
PC3> ping 10.99.99.1

84 bytes from 10.99.99.1 icmp_seq=1 ttl=255 time=0.977 ms
84 bytes from 10.99.99.1 icmp_seq=2 ttl=255 time=1.668 ms
84 bytes from 10.99.99.1 icmp_seq=3 ttl=255 time=1.655 ms
```

Expected Result

Gateway should respond successfully.

Step 8 — Validate ARP & Routing Operations

Goal

Validate enterprise Layer 2 and Layer 3 operations.

R1 Verification

```
R1#show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  10.10.10.1              -   aabb.cc00.1000  ARPA   Ethernet0/0.10
Internet  10.10.10.10             3   0050.7966.6804  ARPA   Ethernet0/0.10
Internet  10.20.20.1              -   aabb.cc00.1000  ARPA   Ethernet0/0.20
Internet  10.20.20.10             3   0050.7966.6805  ARPA   Ethernet0/0.20
Internet  10.99.99.1              -   aabb.cc00.1000  ARPA   Ethernet0/0.99
Internet  10.99.99.10             2   0050.7966.6803  ARPA   Ethernet0/0.99
```

```
R1#show ip route

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.10.10.0/24 is directly connected, Ethernet0/0.1
0
L        10.10.10.1/32 is directly connected, Ethernet0/0.1
0
C        10.20.20.0/24 is directly connected, Ethernet0/0.2
0
L        10.20.20.1/32 is directly connected, Ethernet0/0.2
0
C        10.99.99.0/24 is directly connected, Ethernet0/0.9
9
L        10.99.99.1/32 is directly connected, Ethernet0/0.9
9
R1#
```

SW1 Verification

```
SW1#show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
```

```
----    -----------       --------    -----
  10    0050.7966.6804    DYNAMIC     Et0/1
  10    aabb.cc00.1000    DYNAMIC     Et0/0
  20    0050.7966.6805    DYNAMIC     Et0/2
  20    aabb.cc00.1000    DYNAMIC     Et0/0
  99    0050.7966.6803    DYNAMIC     Et0/3
  99    aabb.cc00.1000    DYNAMIC     Et0/0
Total Mac Addresses for this criterion: 6
```

```
SW1#show interfaces trunk

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

Port            Vlans allowed on trunk
Et0/0           10,20,99

Port            Vlans allowed and active in management domai
n
Et0/0           10,20,99

Port            Vlans in spanning tree forwarding state and
not pruned
Et0/0           10,20,99
```

Expected Result

- ARP entries should populate
- Connected routes should appear
- MAC addresses should learn dynamically

Step 9 — Enterprise Operational Verification

R1 Verification

```
show ip interface brief
show ip route
show arp
```

SW1 Verification

```
show vlan brief
show interfaces trunk
show mac address-table
```

PC1 Verification

```
show ip
ping 10.20.20.10
```

PC2 Verification

```
show ip
ping 10.99.99.10
```

Common Mistakes

Problem	Cause
Inter-VLAN failure	Missing trunk
Gateway unreachable	Wrong subinterface encapsulation
Subinterface DOWN	Physical interface shutdown
Native VLAN mismatch	Incorrect VLAN 99 configuration
Routing failure	Wrong gateway assignment

Enterprise Engineering Notes

- Router-on-a-stick uses a single physical link for multiple VLANs.
- 802.1Q encapsulation enables VLAN tagging.
- Native VLAN traffic remains untagged.
- Enterprise gateway consistency is critical for scalability.
- Inter-VLAN routing introduces Layer 3 segmentation control.

Step 10 — Save Configurations

Router (R1)

```
write memory
```

Switch (SW1)

```
write memory
```

Step 11 — Backup Enterprise Routing Documentation

Goal

Document enterprise gateway architecture.

Suggested Documentation

```
VLAN 10 -> 10.10.10.1
VLAN 20 -> 10.20.20.1
VLAN 99 -> 10.99.99.1
```

What You Learned

In this lab you learned:

- enterprise inter-VLAN routing,
- router-on-a-stick deployment,
- subinterface operations,
- gateway validation,
- VLAN routing troubleshooting,
- enterprise Layer 3 segmentation,
- and enterprise traffic forwarding workflows.

Verification Score

Task	Status
VLANs configured	☐
Trunk operational	☐
Subinterfaces configured	☐
Inter-VLAN routing operational	☐
Gateway validation successful	☐
Configurations saved	☐

Section B — Enterprise Troubleshooting Scenario

Incident Scenario

Users report that VLAN 20 devices cannot communicate outside their VLAN.

Your task:

- investigate the enterprise routing issue,
- identify the root cause,
- and restore enterprise inter-VLAN communication.

Step 1 — Introduce Failure

On R1

```
enable
conf t

interface Ethernet0/0.20
 shutdown

end
```

Step 2 — Verify Failure Symptoms

From PC2

```
ping 10.10.10.10
```

Expected Result

Inter-VLAN communication should fail.

Step 3 — Begin Investigation

Verification Commands

```
show ip interface brief
```

Expected Result

Ethernet0/0.20 should appear administratively DOWN.

Root Cause Analysis

The VLAN 20 gateway subinterface was shut down.

Without an operational gateway:

- VLAN routing fails,
- enterprise communication breaks,
- and departmental isolation becomes unintended.

Step 4 — Restore Enterprise Connectivity

Commands

```
enable
conf t

interface Ethernet0/0.20
 no shutdown

end
```

Step 5 — Validate Recovery

From PC2

```
ping 10.10.10.10
```

Expected Result

Inter-VLAN communication should be restored successfully.

Final Enterprise Validation

Router

```
show ip interface brief
show ip route
```

Switch

```
show interfaces trunk
```

Final Engineering Note

Enterprise routing troubleshooting should always follow a structured workflow:

1. Verify physical connectivity
2. Verify VLAN operations
3. Verify trunk state
4. Verify gateway interfaces
5. Verify routing table
6. Restore connectivity
7. Validate end-to-end recovery

End of Lab 07 — Inter-VLAN Routing & Gateway Design