# Inter-VLAN Routing via Router-on-a-Stick (VLAN 10 & 20)

**Lab Report**

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## I. SUMMARY

This mini-lab was designed as a focused practice exercise to **cement core VLAN and inter-VLAN-routing concepts** before tackling the larger *OfficeNet 3-Way Subnet* project. Using a single Catalyst 2960 switch, an ISR 4331 router, and two end hosts, we:

- **Created isolated Layer-2 domains** (VLAN 10 "USERS" and VLAN 20 "SERVERS") and mapped the corresponding switch access ports.
- **Established an 802.1Q trunk** between the switch and router, then configured sub-interfaces on the router (Gi0/0/0.10 and .20) to act as default gateways.
- **Implemented and validated router-on-a-stick (ROAS) inter-VLAN routing,** confirming full end-to-end connectivity with ICMP tests and show-command verification.

All objectives—segmentation, trunking, gateway assignment, routing, and successful cross-VLAN pings—were achieved without configuration errors. The resulting topology, command set, and troubleshooting notes now serve as a proven reference template for the forthcoming *OfficeNet 3-Way Subnet* project, where similar techniques will be expanded to support three departmental VLANs, additional switches, and more advanced features such as DHCP relay and ACL enforcement.

## II. OBJECTIVES

1. **Create VLAN Segmentation**
   - Define VLAN 10 ("USERS") and VLAN 20 ("SERVERS") on a Catalyst 2960 Layer-2 switch.
2. **Assign and Secure Access Ports**
   - Map PC0 to VLAN 10 and PC1 to VLAN 20, ensuring each host remains in its intended broadcast domain.
3. **Build an 802.1Q Trunk**
   - Configure a single Gigabit trunk (Gi0/1 ↔ Gi0/0/0) to carry tagged traffic for VLANs 10 and 20 between the switch and router.
4. **Implement Router-on-a-Stick Inter-VLAN Routing**
   - Create sub-interfaces Gi0/0/0.10 and Gi0/0/0.20 on an ISR 4331, each with its respective IP gateway address, to enable Layer-3 routing between VLANs.
5. **Apply an IP Addressing Scheme**
   - Allocate unique /24 subnets to each VLAN and set correct default gateways on all end devices.
6. **Verify End-to-End Connectivity**
   - Use ping, show vlan, show interfaces trunk, and show ip route to confirm successful inter-VLAN communication and proper trunk operation.
7. **Document Troubleshooting & Results**

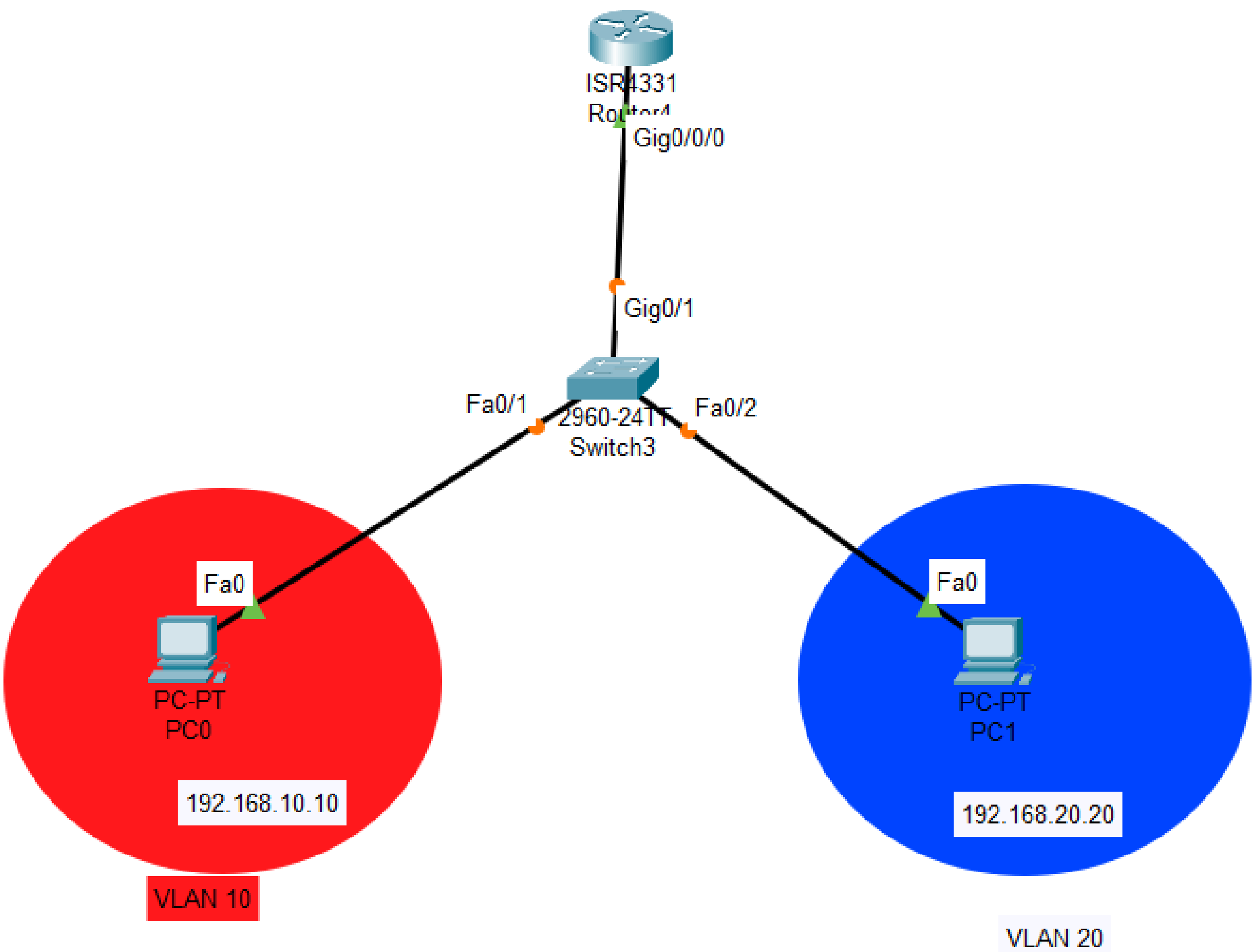
- Record any issues encountered (e.g., trunk mismatches, gateway errors) and the corrective actions taken, providing evidence of a stable, functioning network.

8. **Summarize Key Learnings**

   - Highlight best practices for VLAN design, trunk configuration, and router-on-a-stick deployment relevant to CCNA-level networking.

## III. LAB TOPOLOGY

The lab uses a **simple three-node star topology** that clearly illustrates the flow of traffic from one VLAN, through a Layer-2 switch, up a single 802.1Q trunk to a router performing inter-VLAN routing, and back down to a second VLAN.




### A. Physical Layout

| Node | Model | Interface(s) Used | Links |
|---|---|---|---|
| **Router4** | **ISR 4331** | Gi0/0/0 (physical),Gi0/0/0.10 & .20 (sub-interfaces) | ➜ **Gi0/1** on Switch3 (trunk) |
| **Switch3** | **Catalyst 2960-24TT** | Gi0/1 (trunk to router),Fa0/1 (PC0),Fa0/2 (PC1) | Central aggregation |

| | | | |
|---|---|---|---|
| **PC0** | PC-PT | Fa0 | → **Fa0/1** on Switch3 |
| **PC1** | PC-PT | Fa0 | → **Fa0/2** on Switch3 |

*Refer to the diagram (red & blue ovals) for the visual mapping.*

## B. 2. Logical (VLAN) Layout

| VLAN ID | Name | Associated Port(s) | Subnet / Gateway |
|---|---|---|---|
| **10** | USERS | Switch Fa0/1, PC0 | 192.168.10.0 /24 — **192.168.10.1** |
| **20** | SERVERS | Switch Fa0/2, PC1 | 192.168.20.0 /24 — **192.168.20.1** |

*The switch tags traffic from Fa0/1 with VLAN 10 (red) and from Fa0/2 with VLAN 20 (blue).*

## C. 3. Trunk & Routing Details

| Link | Type | VLANs Carried | Purpose |
|---|---|---|---|
| Switch Gi0/1 ↔ Router Gi0/0/0 | **802.1Q trunk** | 10, 20 (tagged) | Single "router-on-a-stick" uplink that transports both VLANs' traffic to the router for Layer-3 processing |

The router's **sub-interfaces** perform the routing:

- **Gi0/0/0.10** — encapsulation dot1Q 10, IP 192.168.10.1 /24
- **Gi0/0/0.20** — encapsulation dot1Q 20, IP 192.168.20.1 /24

Each sub-interface acts as the *default gateway* for its VLAN.

## D. 4. End-Device Addressing

| Device | VLAN | IP Address | Default Gateway |
|---|---|---|---|
| **PC0** | 10 | 192.168.10.10 /24 | 192.168.10.1 |
| **PC1** | 20 | 192.168.20.20 /24 | 192.168.20.1 |

## E. 5. Traffic Flow Summary

1. **PC0 (VLAN 10) → Switch**: Frame enters Fa0/1 untagged; switch tags it with VLAN 10.
2. **Switch → Router**: Tagged frame travels across the trunk; router maps tag 10 to sub-interface Gi0/0/0.10.

3. **Router → Switch**: After routing, the return packet is tagged with VLAN 20 and sent back down the trunk.

4. **Switch → PC1**: Switch strips VLAN 20 tag, forwards the frame out Fa0/2 to PC1.

   This demonstrates end-to-end connectivity between isolated Layer-2 domains using a single physical link and sub-interface routing—a core CCNA skill.

## IV. IP ADDRESSING AND VLAN TABLE

| VLAN ID | VLAN Name | Subnet (CIDR) | Default Gateway (Router Sub-If) | Switch Access Port(s) | End Device(s) & IPs |
|---|---|---|---|---|---|
| **10** | USERS | 192.168.10.0 /24 | **192.168.10.1** (Gi0/0/0.10) | Fa0/1 | PC0 — 192.168.10.10 |
| **20** | SERVERS | 192.168.20.0 /24 | **192.168.20.1** (Gi0/0/0.20) | Fa0/2 | PC1 — 192.168.20.20 |

*Notes*

• Subnet mask for both networks is **255.255.255.0**.

• The 802.1Q trunk between **Switch Gi0/1** and **Router Gi0/0/0** carries tagged traffic for VLANs 10 & 20.

## V. STEP BY STEP CONFIGURATION

| Step | Device / Mode | Command(s) – enter exactly as shown | Purpose / Expected Outcome |
|---|---|---|---|
| **1** | **Switch3***Global* | vlan 10 name USERSvlan 20 name SERVERS | Create VLAN 10 and VLAN 20 in the switch's VLAN database. |
| **2** | **Switch3***Interface Fa0/1* | interface Fa0/1switchport mode accessswitchport access vlan 10 | Assign PC0's port to VLAN 10. |
| **3** | **Switch3***Interface Fa0/2* | interface Fa0/2switchport mode accessswitchport access vlan 20 | Assign PC1's port to VLAN 20. |

| | | | |
|---|---|---|---|
| 4 | **Switch3***Interface Gi0/1* | interface Gi0/1switchport mode trunkswitchport trunk allowed vlan 10,20switchport nonegotiate | Convert Gi0/1 to an 802.1Q trunk that carries VLANs 10 & 20. |
| 5 | **Switch3***Exec* | show vlan briefshow interfaces trunk | Verify access-port assignments and trunk status. |
| 6 | **Router4***Interface Gi0/0/0* | interface Gig0/0/0description Trunk to Switch3no shutdown | Bring the physical trunk interface up (no IP address here). |
| 7 | **Router4***Sub-if Gi0/0/0.10* | interface Gig0/0/0.10encapsulation dot1Q 10ip address 192.168.10.1 255.255.255.0 | Map VLAN 10 traffic to sub-interface and set its gateway IP. |
| 8 | **Router4***Sub-if Gi0/0/0.20* | interface Gig0/0/0.20encapsulation dot1Q 20ip address 192.168.20.1 255.255.255.0 | Same for VLAN 20. |
| 9 | **Router4***Exec* | show ip interface briefshow ip route connected | Confirm both sub-interfaces are **up/up** and routes exist. |
| 10 | **PC0 (VLAN 10)***IP Config* | IP: 192.168.10.10Mask: 255.255.255.0GW: 192.168.10.1 | Set host address |

| | | | |
|---|---|---|---|
| | | | and default gateway. |
| **11** | **PC1 (VLAN 20)***IP Config* | IP: 192.168.20.20Mask: 255.255.255.0GW: 192.168.20.1 | Set host address and default gateway. |
| **12** | **Any Device***Testing* | From **PC0**: ping 192.168.20.20From **PC1**: ping 192.168.10.10 | ICMP replies confirm successful inter-VLAN routing via the router-on-a-stick setup. |

## VI. VERIFECATION

1. **Confirm VLAN Creation on the Switch**
    - Command: show vlan brief

```
SW1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/3, Fa0/4, Fa0/5, Fa0/6
                                                Fa0/7, Fa0/8, Fa0/9, Fa0/10
                                                Fa0/11, Fa0/12, Fa0/13, Fa0/14
                                                Fa0/15, Fa0/16, Fa0/17, Fa0/18
                                                Fa0/19, Fa0/20, Fa0/21, Fa0/22
                                                Fa0/23, Fa0/24, Gig0/2
10   USER                             active    Fa0/1
20   SERVERS                          active    Fa0/2
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
```

    - Expect to see:
        - VLAN 10 listed with port **Fa0/1**
        - VLAN 20 listed with port **Fa0/2**

2. **Verify Trunk Status on Switch Gi0/1**
    - Command: show interfaces trunk

```
SW1#show interfaces trunk
Port        Mode         Encapsulation  Status        Native vlan
Gig0/1      on           802.1q         trunking      1

Port        Vlans allowed on trunk
Gig0/1      10,20

Port        Vlans allowed and active in management domain
Gig0/1      10,20

Port        Vlans in spanning tree forwarding state and not pruned
Gig0/1      10,20
```

- Expect to see:
  - Port Gi0/1 operating as **trunk**
  - Allowed VLANs: 10, 20

3. **Check Router Sub-Interface Status**
   - Command: show ip interface brief

```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status
Protocol
GigabitEthernet0/0/0   unassigned      YES unset  up                    up
GigabitEthernet0/0/0.10192.168.10.1    YES manual up                    up
GigabitEthernet0/0/0.20192.168.20.1    YES manual up                    up
GigabitEthernet0/0/1   unassigned      YES unset  administratively down down
GigabitEthernet0/0/2   unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
R1#
```

- Expect to see both sub-interfaces **up/up**:
  - Gi0/0/0.10 → 192.168.10.1
  - Gi0/0/0.20 → 192.168.20.1

4. **Inspect Router's Connected Routes**
   - Command: show ip route connected

```
R1#show ip route connected
 C    192.168.10.0/24  is directly connected, GigabitEthernet0/0/0.10
 C    192.168.20.0/24  is directly connected, GigabitEthernet0/0/0.20

R1#
```

- Expect to see:
  - C 192.168.10.0/24 is directly connected, Gi0/0/0.10

        - C 192.168.20.0/24 is directly connected, Gi0/0/0.20
    - *Insert Screenshot 4 here (routing table)*

5. **Ping Test — PC0 to Its Gateway**
    - From PC0: ping 192.168.10.1
    - Expect: 4/4 replies, 0 % loss

```
C:\>ping 192.168.10.1

Pinging 192.168.10.1 with 32 bytes of data:

Reply from 192.168.10.1: bytes=32 time<1ms TTL=255
Reply from 192.168.10.1: bytes=32 time<1ms TTL=255
Reply from 192.168.10.1: bytes=32 time<1ms TTL=255
Reply from 192.168.10.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.10.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

6. **Ping Test — PC1 to Its Gateway**
    - From PC1: ping 192.168.20.1
    - Expect: 4/4 replies, 0 % loss

```
C:\>ping 192.168.20.1

Pinging 192.168.20.1 with 32 bytes of data:

Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.20.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

7. **Inter-VLAN Connectivity Test**
    - From PC0: ping 192.168.20.20

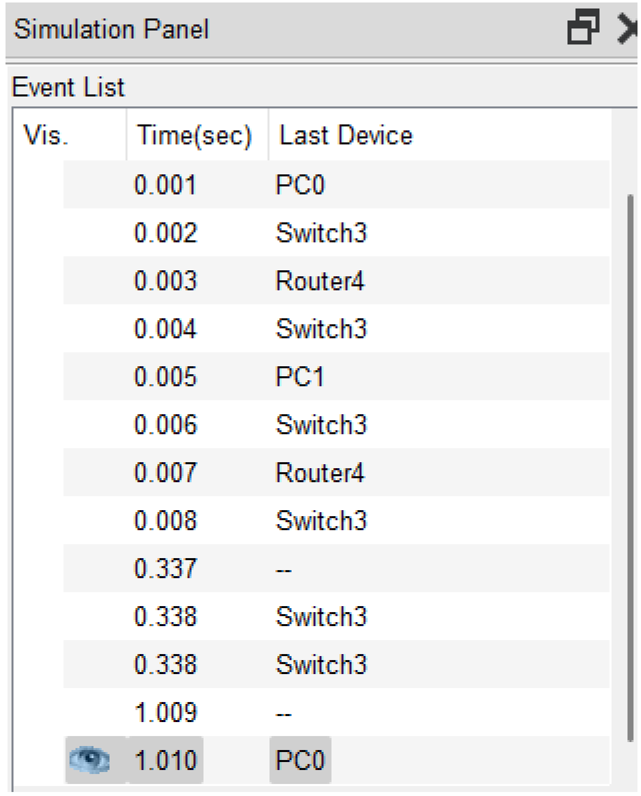
```
C:\>ping 192.168.20.20

Pinging 192.168.20.20 with 32 bytes of data:

Reply from 192.168.20.20: bytes=32 time<1ms TTL=127
Reply from 192.168.20.20: bytes=32 time<1ms TTL=127
Reply from 192.168.20.20: bytes=32 time<1ms TTL=127
Reply from 192.168.20.20: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.20:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

    - From PC1: ping 192.168.10.10

```
C:\>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:

Reply from 192.168.10.10: bytes=32 time<1ms TTL=127
Reply from 192.168.10.10: bytes=32 time<1ms TTL=127
Reply from 192.168.10.10: bytes=32 time<1ms TTL=127
Reply from 192.168.10.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.10.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

    - Expect: Successful replies in both directions, proving router-on-a-stick routing works.

8. **Packet Flow Illustration**
    - Use Packet Tracer **Simulation Mode** to capture an ICMP Echo Request and Reply traversing VLAN 10 → router → VLAN 20.



Simulation Panel

Event List

| Vis. | Time(sec) | Last Device |
|---|---|---|
| | 0.001 | PC0 |
| | 0.002 | Switch3 |
| | 0.003 | Router4 |
| | 0.004 | Switch3 |
| | 0.005 | PC1 |
| | 0.006 | Switch3 |
| | 0.007 | Router4 |
| | 0.008 | Switch3 |
| | 0.337 | -- |
| | 0.338 | Switch3 |
| | 0.338 | Switch3 |
| | 1.009 | -- |
| | 1.010 | PC0 |