Multilayer

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Contents

Chapter 1

Tutorial: Inter-VLAN Routing with ROAS and Multilayer Switches

1.1 Introduction

Virtual Local Area Networks (VLANs) are used in network environments to segment traffic and improve performance and security. However, devices in separate VLANs cannot communicate with each other by default. Inter-VLAN routing allows devices from different VLANs to communicate, and this can be achieved through two main methods: **Router-on-a-Stick (ROAS)** and **Multilayer Switch (MLS) Inter-VLAN Routing**.

1.2 Router-on-a-Stick (ROAS)

1.2.1 Overview

Router-on-a-Stick (ROAS) is a method of inter-VLAN routing that uses a single router with a trunk link to a switch. The router performs all routing functions between VLANs.

1.2.2 How It Works

1. A trunk link is established between the router and the switch.
2. Subinterfaces are created on the router for each VLAN.
3. Each subinterface is assigned an IP address that acts as the default gateway for its respective VLAN.
4. The switch forwards VLAN-tagged traffic to the router, which then routes it to the appropriate VLAN.

1.2.3 Configuration Steps

On the Switch

```
configure terminal
interface GigabitEthernet0/1
switchport mode trunk
switchport trunk allowed vlan 10,20
exit
```

On the Router

```
configure terminal
interface GigabitEthernet0/1
no shutdown
interface GigabitEthernet0/1.10
encapsulation dot1Q 10
ip address 192.168.10.1 255.255.255.0
exit
interface GigabitEthernet0/1.20
encapsulation dot1Q 20
ip address 192.168.20.1 255.255.255.0
exit
```

1.2.4 Advantages and Disadvantages

Advantages:

- Cost-effective for small networks.
- Simple to implement.

Disadvantages:

- Limited scalability due to reliance on a single router interface.
- Potential bottleneck due to the router processing all inter-VLAN traffic.

1.3 Inter-VLAN Routing with a Multilayer Switch (MLS)

1.3.1 Overview

A multilayer switch (MLS) can perform routing functions at Layer 3, eliminating the need for an external router.

1.3.2 How It Works

1. The MLS is configured with Switched Virtual Interfaces (SVIs) for each VLAN.
2. Each SVI is assigned an IP address that acts as the default gateway for its VLAN.
3. The MLS handles inter-VLAN routing internally, reducing latency.

1.3.3 Configuration Steps

Enable Routing on the Switch

```
configure terminal
ip routing
```

Create and Configure SVIs

```
interface vlan 10
ip address 192.168.10.1 255.255.255.0
no shutdown
exit
interface vlan 20
ip address 192.168.20.1 255.255.255.0
no shutdown
exit
```

1.3.4 Advantages and Disadvantages

Advantages:

- Higher performance as traffic remains within the switch.
- Scalability for larger networks.
- Reduced latency due to elimination of external routing hops.

Disadvantages:

- Higher cost compared to ROAS.
- Requires a switch with Layer 3 capabilities.

1.4 Choosing Between ROAS and MLS

Feature	Router-on-a-Stick (ROAS)	Multilayer Switch (MLS)
Cost	Lower	Higher
Performance	Slower (bottlenecks)	Faster
Scalability	Limited	Scalable
Complexity	Simple	Moderate
Hardware Needed	Router & L2 Switch	L3 Switch

Table 1.1: Comparison of ROAS and MLS

For small networks with limited VLANs, ROAS is a cost-effective solution. For larger enterprise networks requiring higher performance, MLS is the preferred method.

1.5 Conclusion

Inter-VLAN routing is essential for modern networks to ensure seamless communication between VLANs. While ROAS is a simple and cost-effective solution, MLS offers improved performance and scalability. Choosing the right method depends on network size, traffic load, and budget considerations. Implementing the correct inter-VLAN routing solution ensures an efficient, high-performing, and well-segmented network infrastructure.

Part I

Exercises and Hands-On Practice

Chapter 2

Router-on-a-Stick (ROAS)

1. Configure the `GigabitEthernet0/0` interface as a trunk.
2. Assign subinterface `0/0.10` for VLAN 10 with IP `192.168.10.1/24`.
3. Assign subinterface `0/0.20` for VLAN 20 with IP `192.168.20.1/24`.
4. Assign subinterface `0/0.30` for VLAN 30 with IP `192.168.30.1/24`.
5. Enable 802.1Q encapsulation on subinterface `GigabitEthernet0/0.10`.
6. Enable 802.1Q encapsulation on subinterface `GigabitEthernet0/0.20`.
7. Enable 802.1Q encapsulation on subinterface `GigabitEthernet0/0.30`.
8. Enable IP routing on the router.
9. Verify VLANs on the switch.
10. Configure `FastEthernet0/1` as a trunk on Switch1.
11. Configure `FastEthernet0/1` as a trunk on Switch2.
12. Configure `FastEthernet0/1` as a trunk on Switch3.
13. Assign `FastEthernet0/2` on Switch1 to VLAN 10.
14. Assign `FastEthernet0/2` on Switch2 to VLAN 20.
15. Assign `FastEthernet0/2` on Switch3 to VLAN 30.
16. Set PC1's gateway to `192.168.10.1`.
17. Set PC2's gateway to `192.168.20.1`.
18. Set PC3's gateway to `192.168.30.1`.
19. Verify trunking status on switches.
20. Show the current VLAN configuration.
21. Display the routing table to check inter-VLAN routing.
22. Show all subinterfaces configured on the router.
23. Check encapsulation settings for all subinterfaces.
24. Verify if PC1 can ping PC2.

25. Verify if PC3 can ping PC1.
26. Save the running configuration.
27. Debug IP routing issues.
28. Remove subinterface `0/0.30`.
29. Disable the trunk link on Switch1.
30. Reset the router configuration.

Chapter 3

Multilayer Switch (MLS)

1. Enable IP routing on the multilayer switch.
2. Create VLAN 10 on the switch.
3. Create VLAN 20 on the switch.
4. Create VLAN 30 on the switch.
5. Assign `interface VLAN 10` an IP address `192.168.10.1/24`.
6. Assign `interface VLAN 20` an IP address `192.168.20.1/24`.
7. Assign `interface VLAN 30` an IP address `192.168.30.1/24`.
8. Assign `interface FastEthernet0/1` to VLAN 10.
9. Assign `interface FastEthernet0/2` to VLAN 20.
10. Assign `interface FastEthernet0/3` to VLAN 30.
11. Configure trunking on `FastEthernet0/24`.
12. Allow VLAN 10, 20, and 30 on trunk `FastEthernet0/24`.
13. Set `FastEthernet0/24` as a dynamic desirable trunk.
14. Assign PC1's default gateway to `192.168.10.1`.
15. Assign PC2's default gateway to `192.168.20.1`.
16. Assign PC3's default gateway to `192.168.30.1`.
17. Verify VLAN assignments on the switch.
18. Display trunk ports status.
19. Show the switch routing table.
20. Enable HSRP (Hot Standby Router Protocol) for VLAN 10.
21. Enable HSRP for VLAN 20.
22. Enable HSRP for VLAN 30.
23. Configure SVI (Switched Virtual Interface) for VLAN 10.
24. Configure SVI for VLAN 20.

25. Configure SVI for VLAN 30.
26. Show all SVI interfaces.
27. Verify if PC1 can ping PC2.
28. Verify if PC3 can ping PC1.
29. Debug SVI connectivity issues.
30. Reset the multilayer switch configuration.

Part II

Answer Key and Explanations

Chapter 4

Router-on-a-Stick (ROAS) - Answers

1. Configure the `GigabitEthernet0/0` interface as a trunk.

```
interface GigabitEthernet0/0
no shutdown
```

2. Assign subinterface `0/0.10` for VLAN 10 with IP `192.168.10.1/24`.

```
interface GigabitEthernet0/0.10
encapsulation dot1Q 10
ip address 192.168.10.1 255.255.255.0
```

3. Assign subinterface `0/0.20` for VLAN 20 with IP `192.168.20.1/24`.

```
interface GigabitEthernet0/0.20
encapsulation dot1Q 20
ip address 192.168.20.1 255.255.255.0
```

4. Assign subinterface `0/0.30` for VLAN 30 with IP `192.168.30.1/24`.

```
interface GigabitEthernet0/0.30
encapsulation dot1Q 30
ip address 192.168.30.1 255.255.255.0
```

5. Enable IP routing on the router.

```
ip routing
```

6. Verify VLANs on the switch.

```
show vlan brief
```

7. Configure trunking on Switch1 (`FastEthernet0/1`).

```
interface FastEthernet0/1
switchport mode trunk
```

8. Configure VLANs on the switch.

```
vlan 10
vlan 20
vlan 30
```

9. Assign a PC's gateway.

```
ip default-gateway 192.168.10.1
```

10. Display the routing table to check inter-VLAN routing.

```
show ip route
```

11. Save the running configuration.

```
write memory
```

12. Debug IP routing issues.

```
debug ip routing
```

13. Remove subinterface for VLAN 30.

```
no interface GigabitEthernet0/0.30
```

14. Reset the router configuration.

```
erase startup-config
reload
```

Chapter 5

Multilayer Switch (MLS) - Answers

1. Enable IP routing on the multilayer switch.

```
ip routing
```

2. Create VLAN 10 on the switch.

```
vlan 10
```

3. Assign `interface VLAN 10` an IP address `192.168.10.1/24`.

```
interface vlan 10
ip address 192.168.10.1 255.255.255.0
no shutdown
```

4. Assign FastEthernet0/1 to VLAN 10.

```
interface FastEthernet0/1
switchport mode access
switchport access vlan 10
```

5. Configure trunking on `FastEthernet0/24`.

```
interface FastEthernet0/24
switchport mode trunk
switchport trunk allowed vlan 10,20,30
```

6. Set PC1's default gateway.

```
ip default-gateway 192.168.10.1
```

7. Show VLAN assignments.

```
show vlan brief
```

8. Show the switch routing table.

```
show ip route
```

9. Enable HSRP for VLAN 10.

```
interface vlan 10
standby 1 ip 192.168.10.254
```

10. Configure Switched Virtual Interface (SVI) for VLAN 20.

```
interface vlan 20
ip address 192.168.20.1 255.255.255.0
no shutdown
```

11. Show all SVI interfaces.

```
show ip interface brief
```

12. Verify connectivity between VLANs using ping.

```
ping 192.168.20.1
```

13. Debug SVI connectivity issues.

```
debug ip routing
```

14. Reset the multilayer switch configuration.

```
erase startup-config
reload
```

Chapter 6

Answers to ROAS Exercises

6.1 VLAN & Trunking Configuration Answers

6.2 Router Subinterface Configuration Answers

6.3 Troubleshooting ROAS Answers

6.4 ACL and DHCP Configuration Answers

Chapter 7

Answers to Multilayer Switch Exercises

7.1 VLAN and SVI Configuration Answers

7.2 IP Routing and EtherChannel Answers

7.3 Routing Protocol Configuration Answers

Appendix A

Cisco IOS Command Reference

Appendix B

Troubleshooting Common VLAN and Inter-VLAN Issues

Appendix C

Additional Study Resources and Certification Guide