VxLEARN Networks

Networking & Cybersecurity Track
Simulated Employment Program

Lab Report:
Observe Traffic Flow in a Routed Network

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1. Introduction

This report demonstrates how network segmentation and routing improve efficiency in a growing business environment.

Using Cisco Packet Tracer, we observed how broadcast traffic behaves in a single flat network, then reconfigured the network into separate routed subnets, and compared the traffic patterns before and after routing.

2. Background and Scenario

XYZ LLC is expanding rapidly and is currently using a single flat network for all departments. With approximately 150 connected devices, this design has led to performance issues due to excessive broadcast traffic.

To address this, a routed network design will be implemented. Routing separates departments into independent subnetworks, improving traffic handling, segmentation, and scalability.

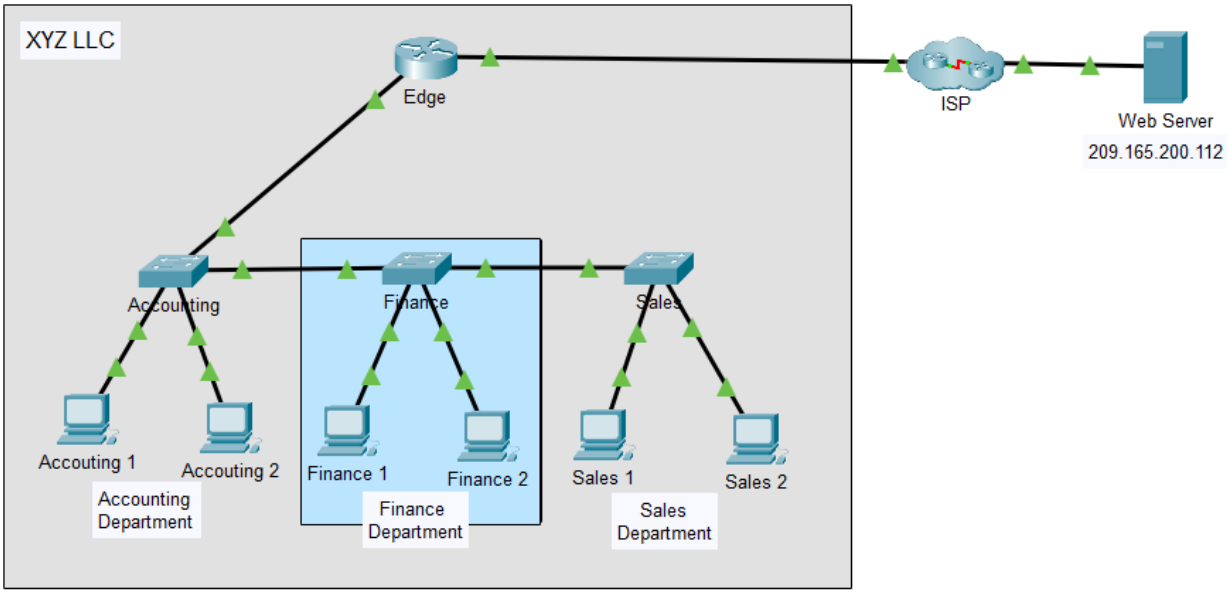
3. Objectives

- Observe communication in a single broadcast domain.
- Reconfigure the network to support multiple routed networks.
- Compare network behavior before and after routing is applied.

4. Network Topology Overview

Initially:

- All hosts are in one LAN.
- The router only provides connectivity to the ISP.
- Department switches: one switch per department (Sales, Finance, Accounting).
- Host devices: multiple PCs connected to each department switch (e.g., Sales1, Sales2, etc.).
- Switch interconnections: the department switches are connected to each other using Ethernet links so they form one big switched fabric.
- Edge Router: one router connected to the switch fabric; it provides Internet/ISP access via its WAN interface (to the cloud). The router's LAN interface is also connected into the same switch fabric.



After reconfiguration:

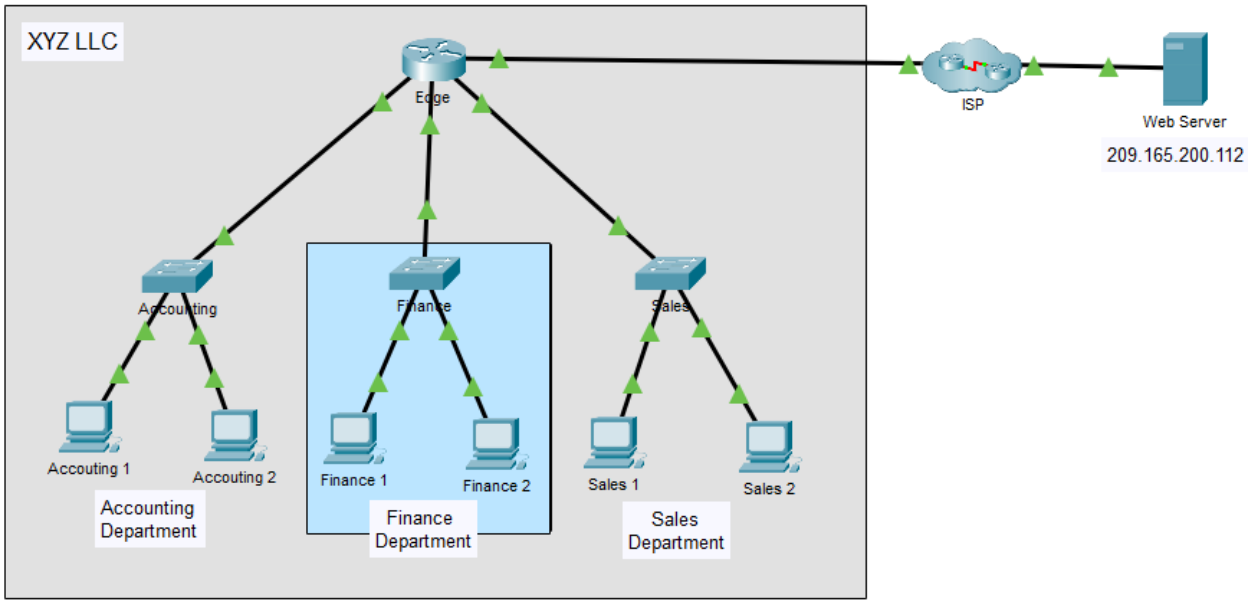
• Each department switch now connects directly to its own Edge router interface.

• The old switch-to-switch links were removed, so the single large broadcast domain is gone.

• Accounting, Finance, and Sales each run on their own IPv4 subnet provided by the router's DHCP service.

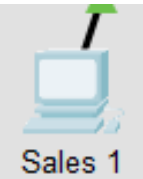
• All interdepartment traffic now flows through the router instead of flooding the LAN.

• Broadcasts stay inside each department network, improving efficiency and reducing congestion.



5. Part 1 – Observe Traffic Flow in an Unrouted LAN

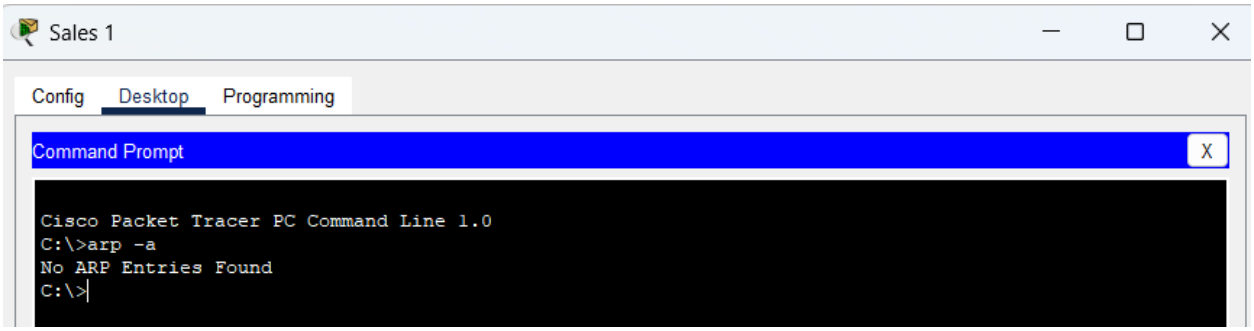
Step 1: Clear the ARP cache on host Sales 1.



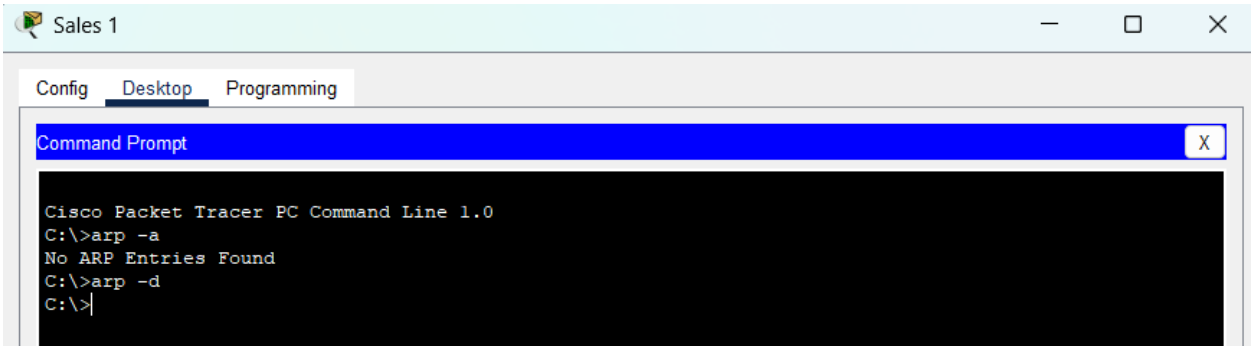
Open Sales 1 > Desktop > Command Prompt

Run: `arp -a` (displays the current ARP table)

If entries exist: `arp -d` (clears all ARP entries)



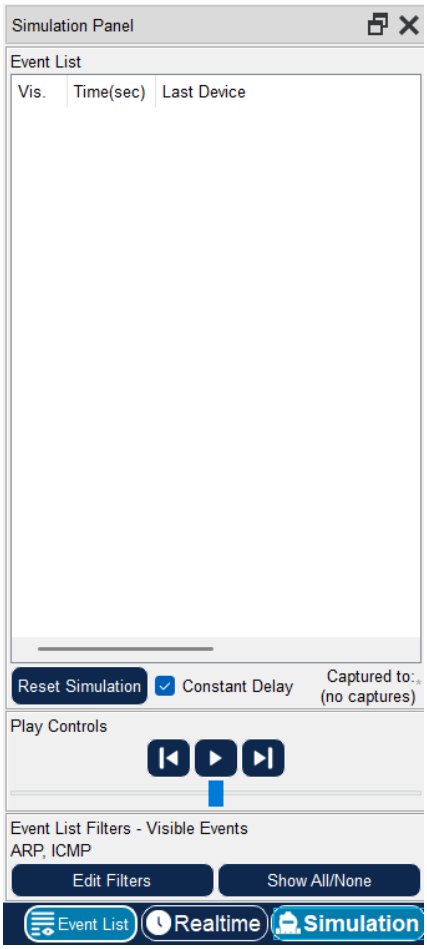
Sales1 ARP before



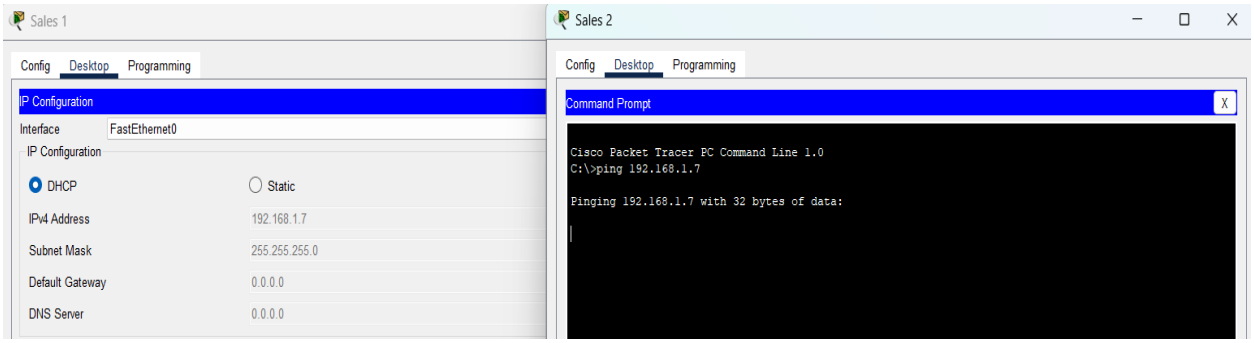
Sales1 ARP after

Step 2: Observe Traffic Flow in Simulation Mode

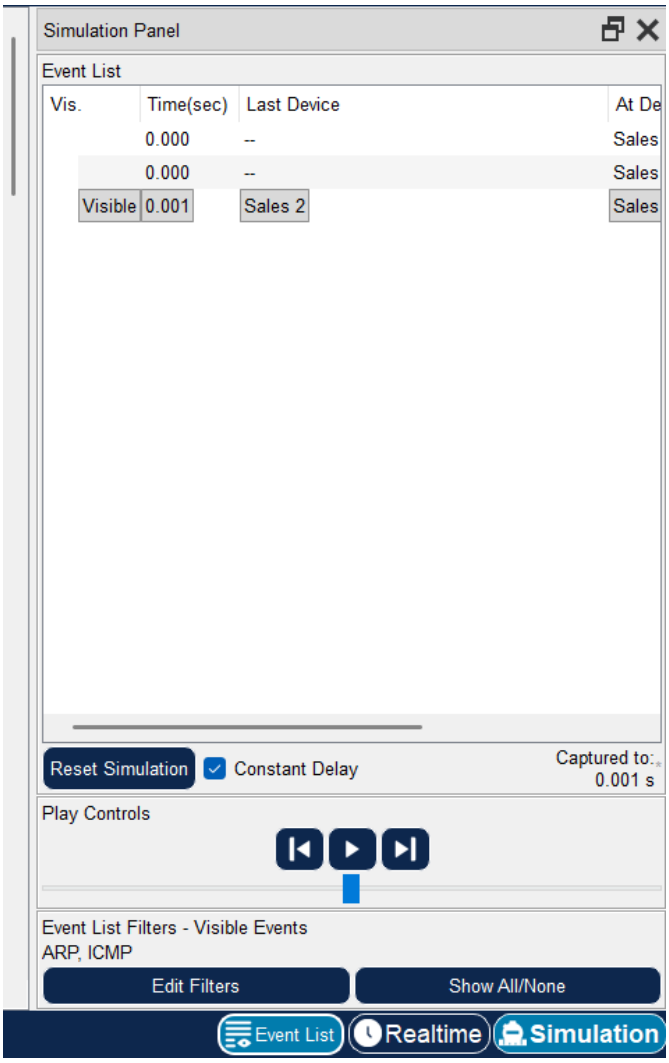
a. Enter Simulation mode

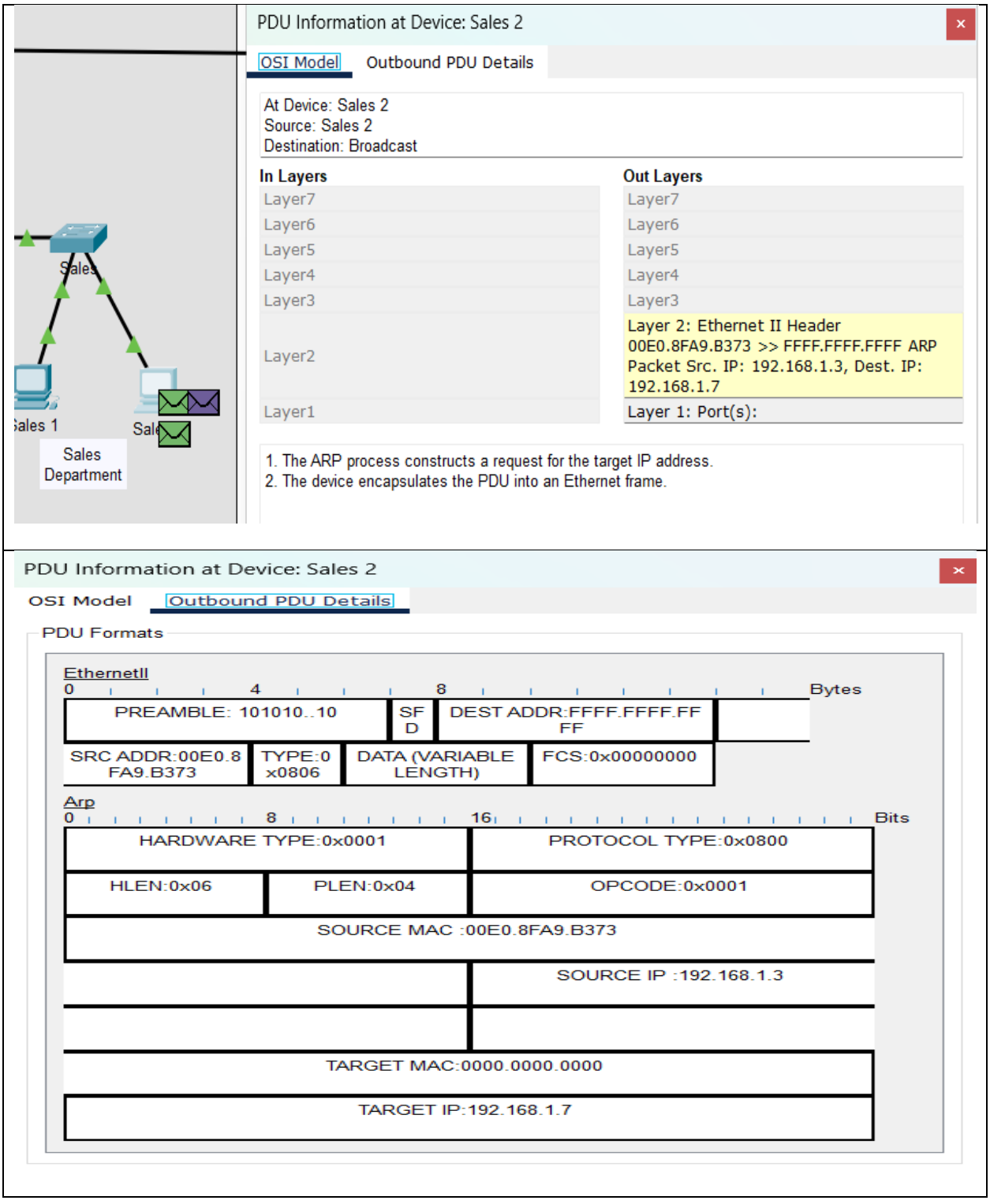


b. On Sales 2 run: ping 192.168.1.7 (Sales1_IP)



c. Use Capture / Forward to observe PDUs (the triangle pointing to the right with a vertical bar attached in the Play Controls of the Simulation Panel)





Initial PDU - You will see a colored envelope appear this envelope is the ARP request.

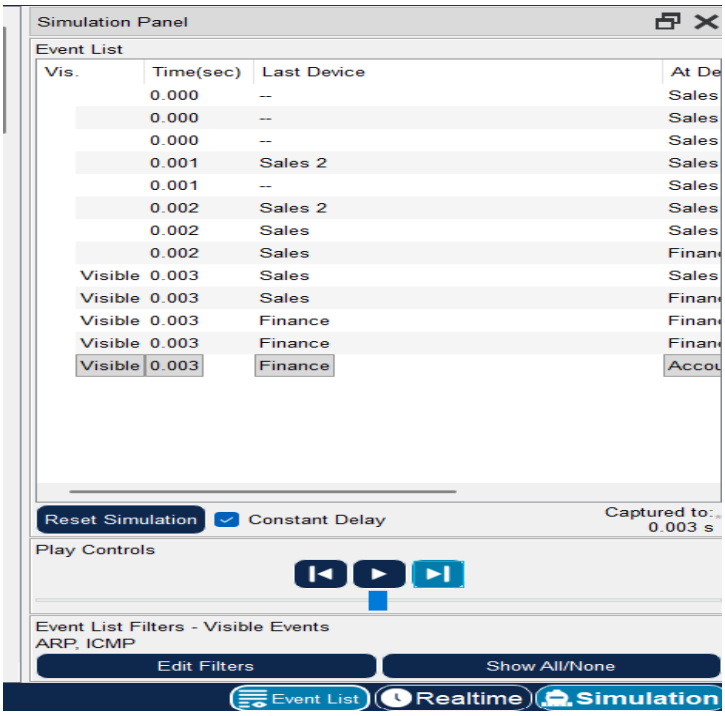
Source/Destination MAC/IP?

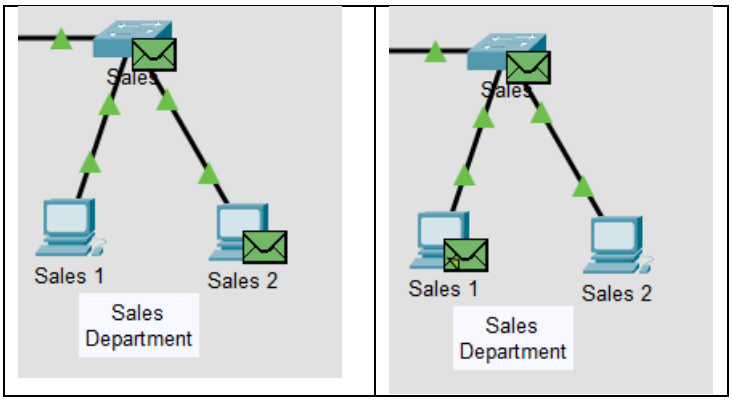
- Source MAC: Sales 2's MAC address (00E0.8FA9.B373)
- Destination MAC: **ff:ff:ff:ff:ff:ff** (broadcast)
- Source IP: Sales 2's IP address (192.168.1.3)
- Destination IP: Sales 1's IP address (192.168.1.7)

Why is the destination MAC broadcast?

- Because Sales 2 does not yet know Sales 1's MAC address, so it must send an **ARP request** to every device on the LAN to discover it.

d. Advance PDUs until new PDU appears





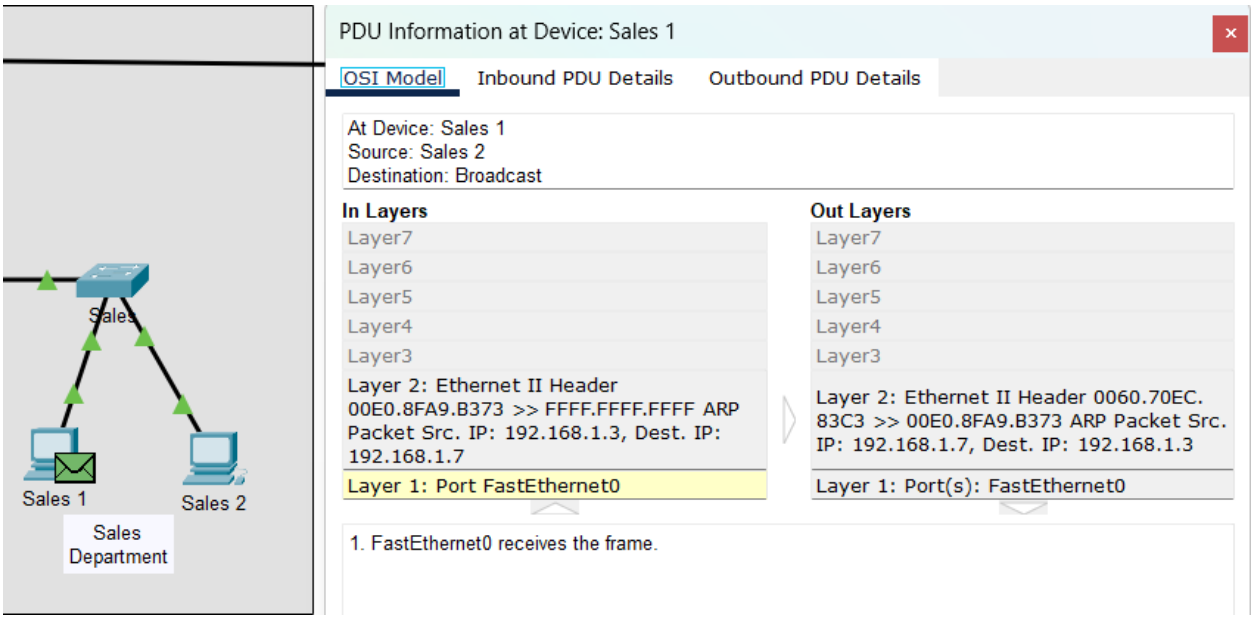
This movement is the "ARP Request Path"

Observation of ARP Request Movement
When Sales 2 sends the ping, it first creates an ARP request because it does not know Sales 1's MAC address. The ARP request is broadcast, so the PDU leaves Sales 2, goes to the switch, and is forwarded out all switch ports. Every device on the LAN receives the broadcast, including Sales 1. Sales 1 recognizes its own IP in the ARP request and prepares an ARP reply, while all other devices simply ignore it.

Which devices processed the ARP request packets?
All hosts and the switch on the LAN receive the ARP broadcast. Only Sales 1 replies, but every device must process the request.

How does this affect network efficiency?
Because ARP requests are broadcast, every device on the LAN is interrupted and must inspect the packet. As the LAN grows, these frequent broadcasts create unnecessary traffic and slow the network down.

e. Inspect new PDU



ARP Reply

What type of PDU is this?
It is an **ARP Reply** (also called an ARP Response).

Source/Destination MAC/IP?

• Source MAC: This is the MAC address of Sales 1, the device replying. (00E0.8FA9.B373)

• Destination MAC: This is Sales 2's MAC address, the requester. (00E0.8FA9.B373)

• Source IP: Sales 1's IP address (192.168.1.3)

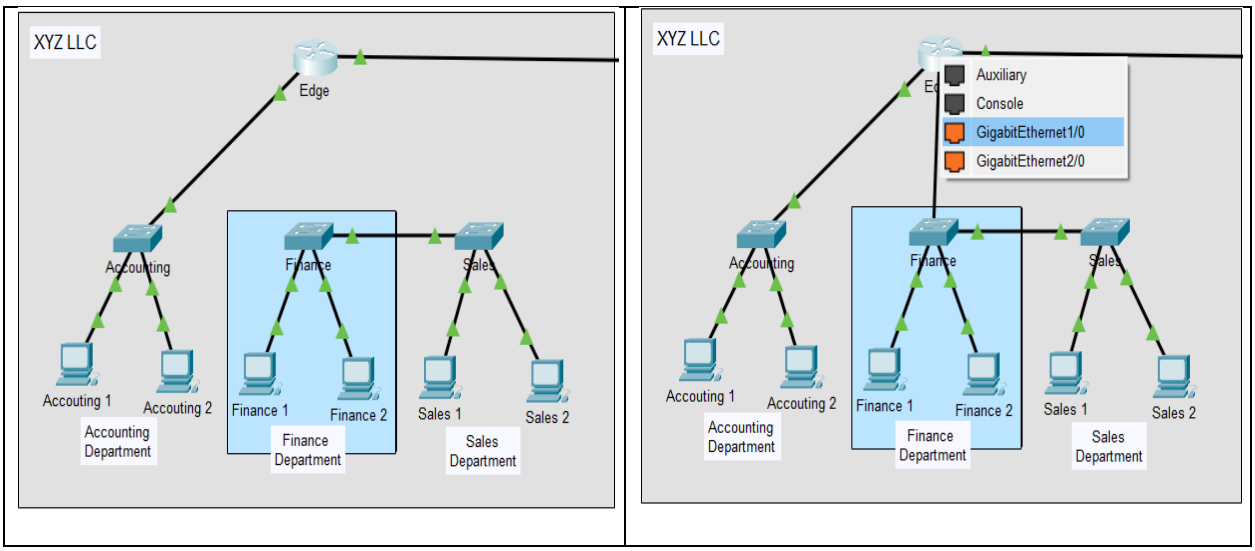
• Destination IP: Sales 2's IP address (192.168.1.7)

6. Part 2: Reconfiguring the Network for Routed Communication

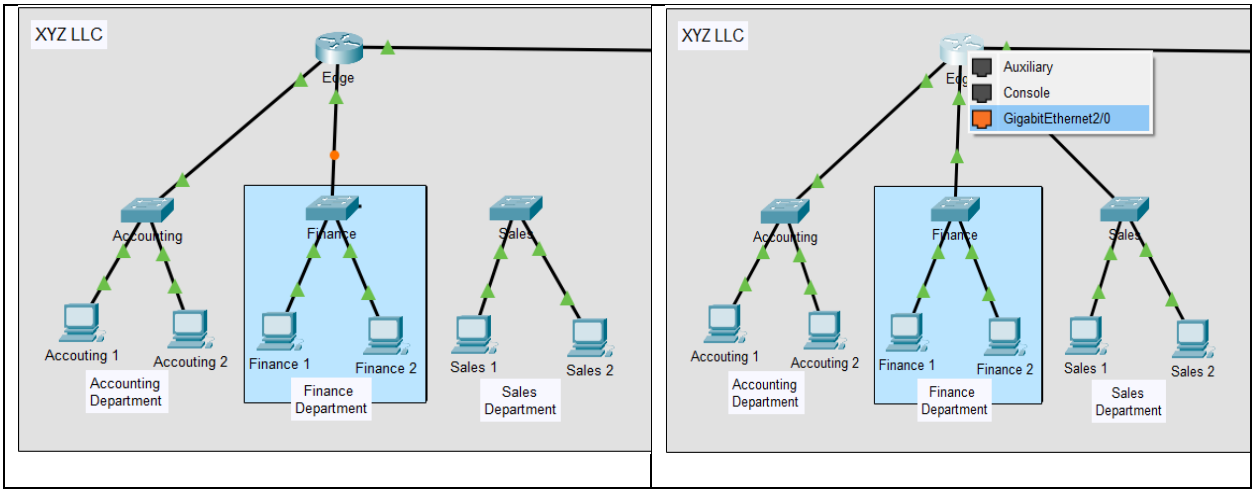
Step 1 – Re-cable Each Switch Directly to the Router

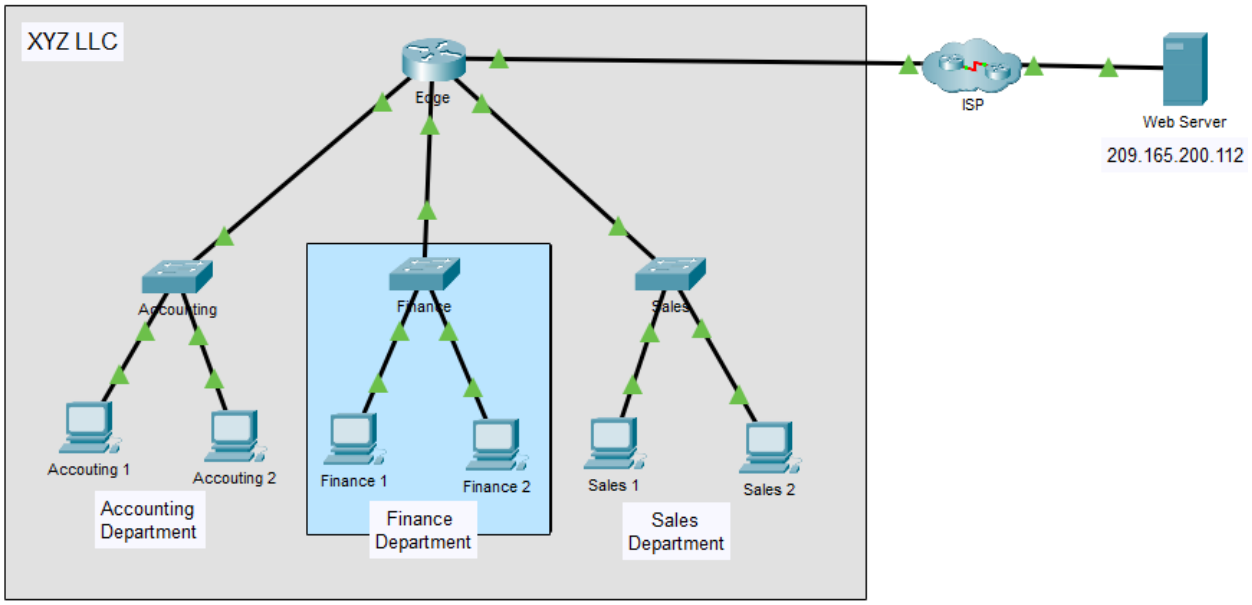
Sales, Finance, Accounting → connect individually to Edge Router GigabitEthernet interfaces.

a. Disconnect Accounting-Finance link; reconnect Accounting switch to Edge router Gi1/0



b. Repeat for Finance-Sales link; connect to available router port

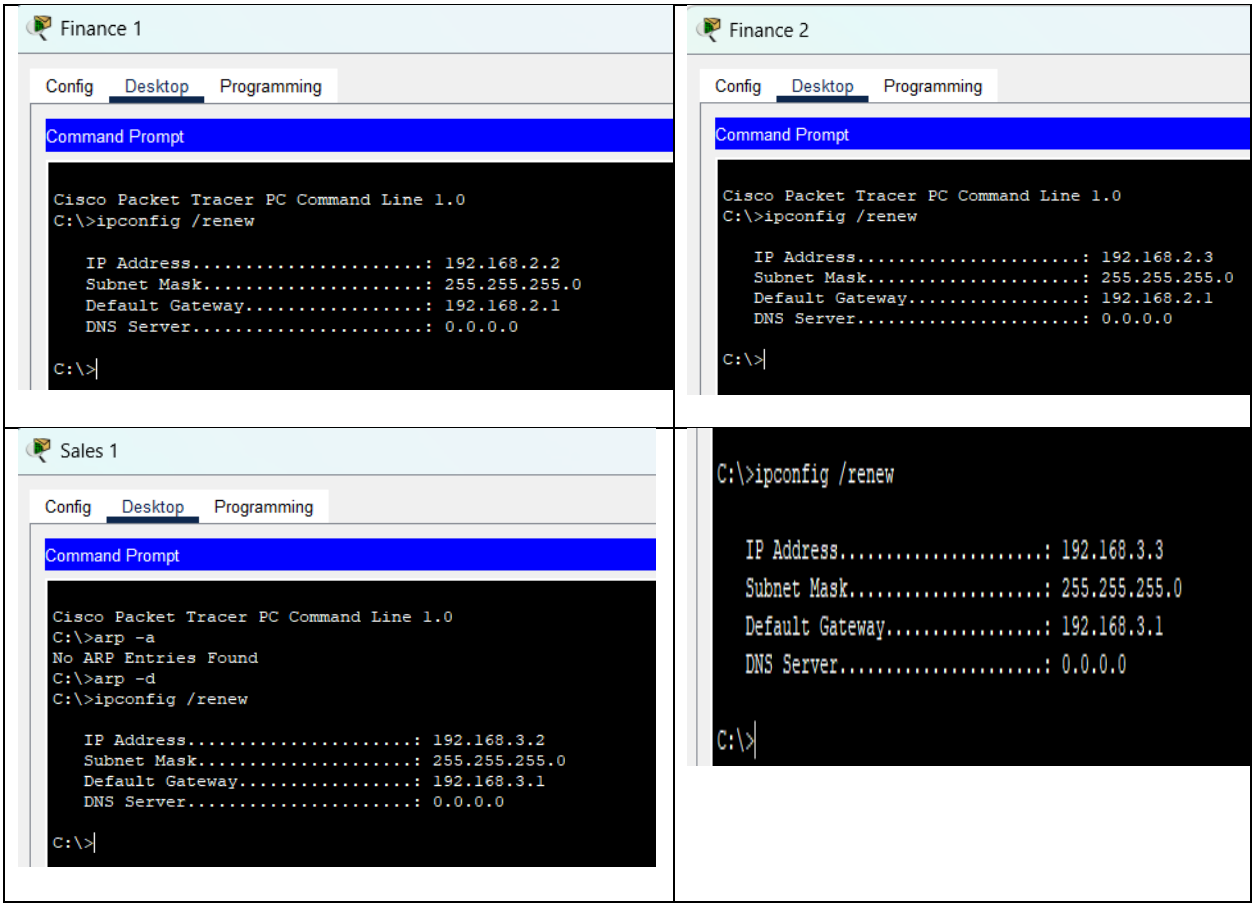




Updated Topology

Step 2 – Force Clients to Renew IP Addresses

a. Open Command Prompt on Finance and Sales hosts; run ipconfig /renew



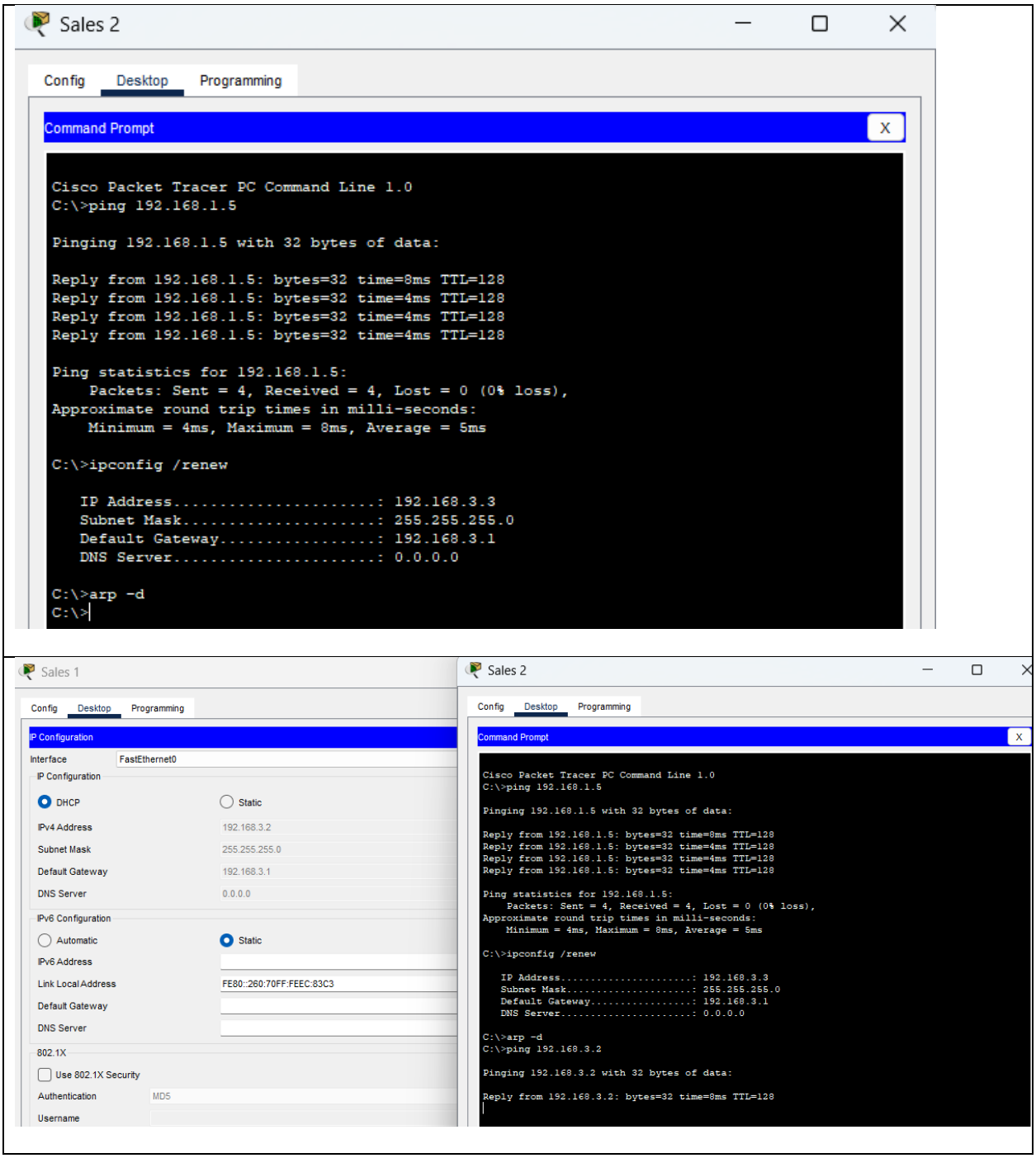
Record New Networks

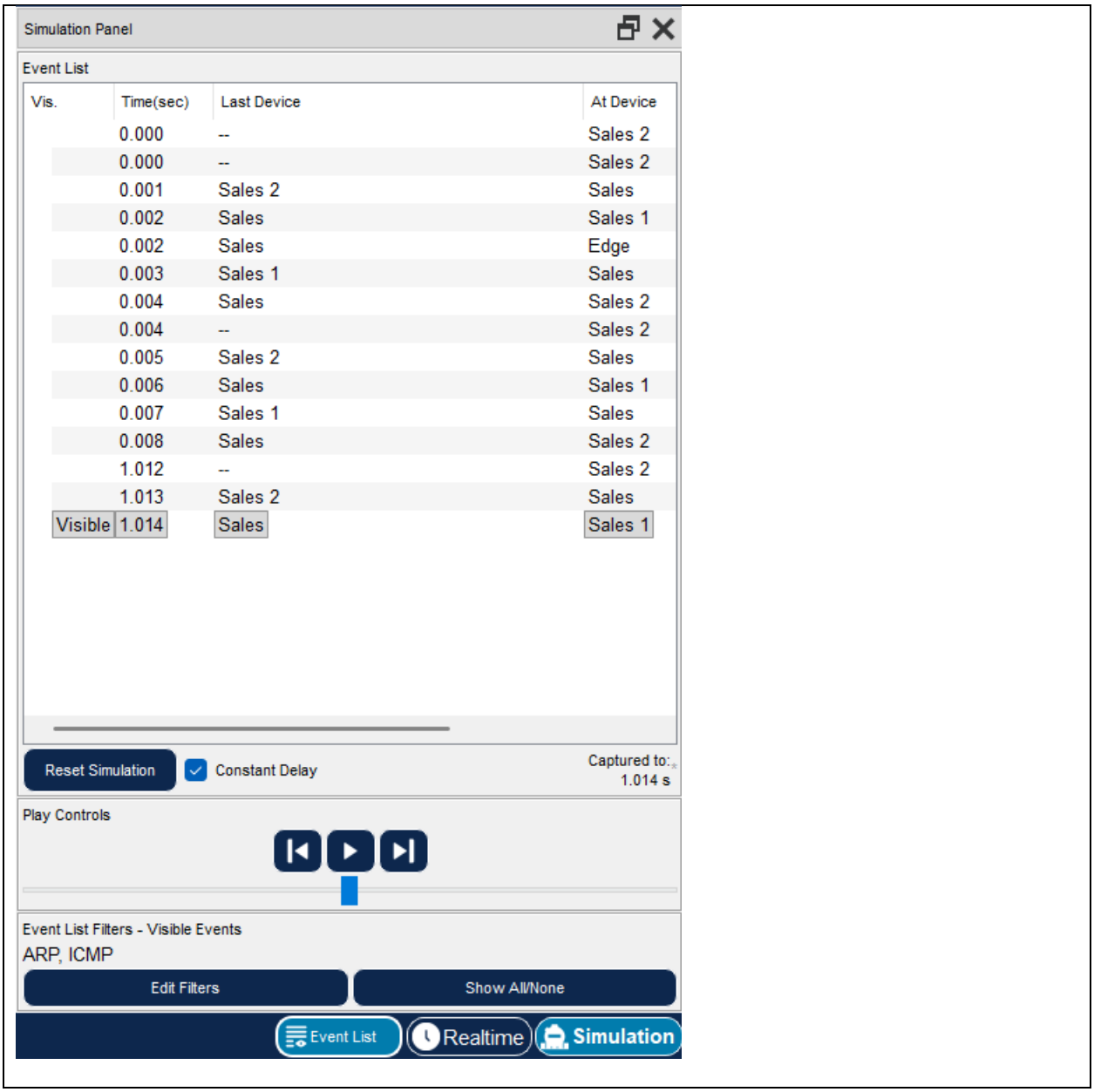
Department	New IPv4 Network	Gateway Address
Finance	192.168.2.0/24	192.168.2.1
Sales	192.168.3.0/24	192.168.3.1
Accounting	192.168.1.0/24	192.168.1.1

7. Part 3 – Observe Traffic Flow in the Routed Network

Step 1 – Ping Sales 1 from Sales 2 Again

Repeat ARP + Ping in Simulation Mode.



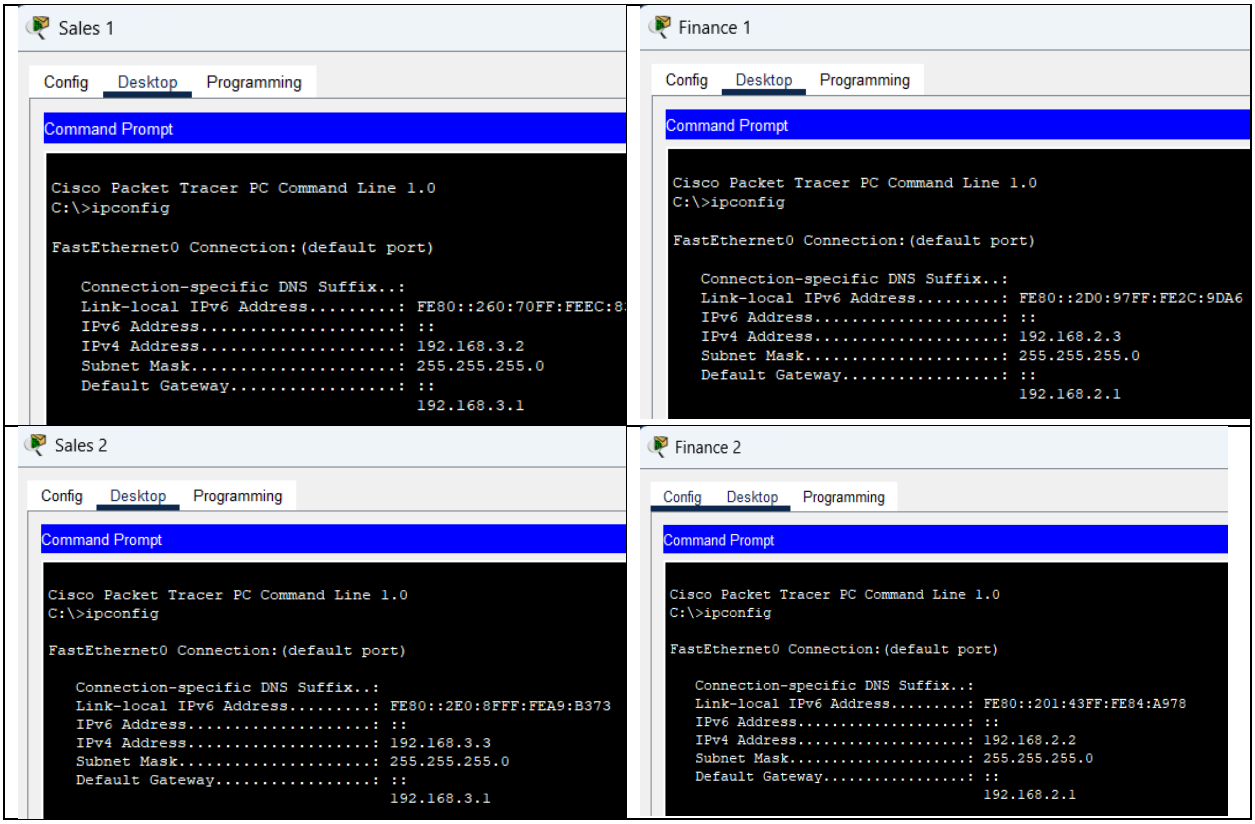


Routed ARP Behaviour

Pinging Between Networks

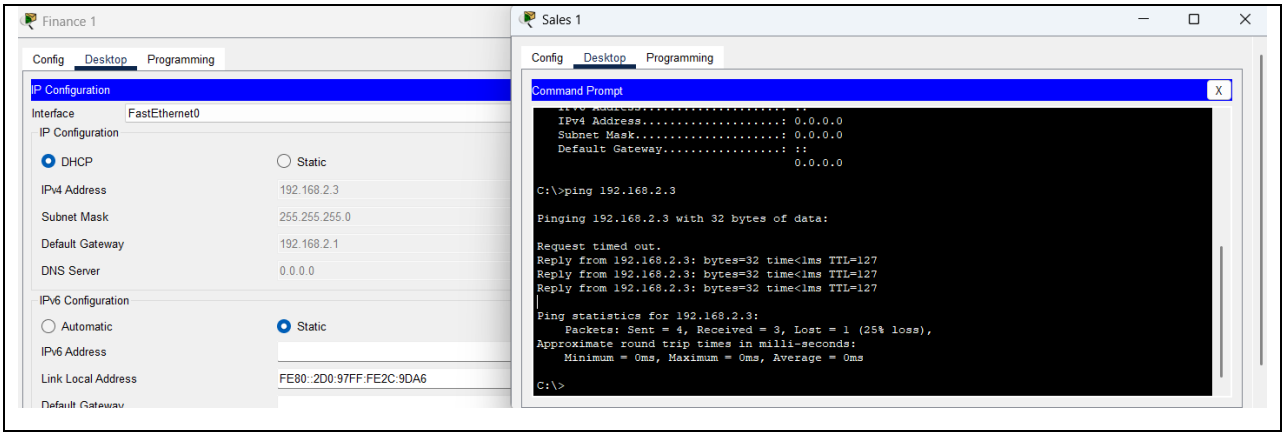
Step 1: Verify IP Configuration

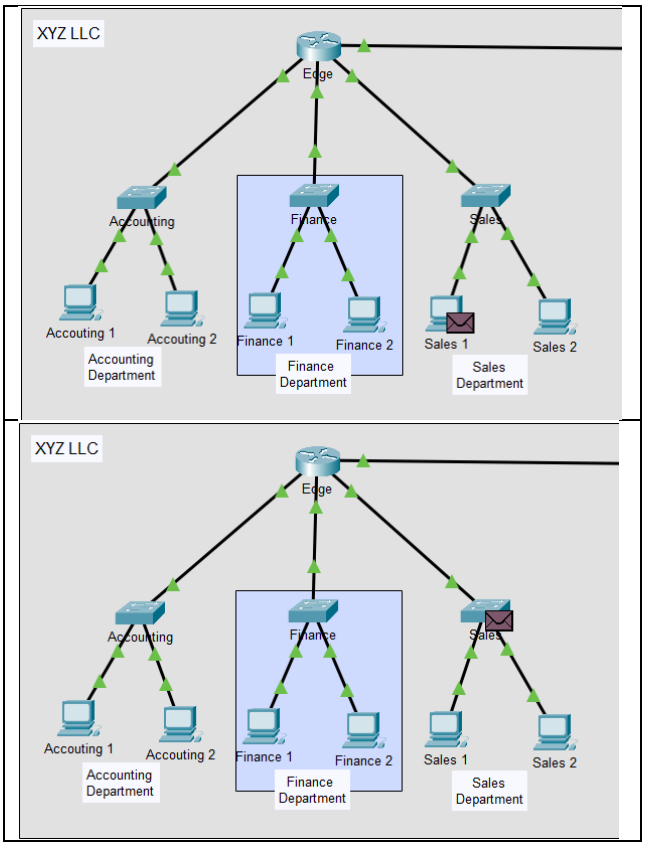
1. Go to **each PC** → *Desktop* → *Command Prompt*.
2. Type:
   `Ipconfig`

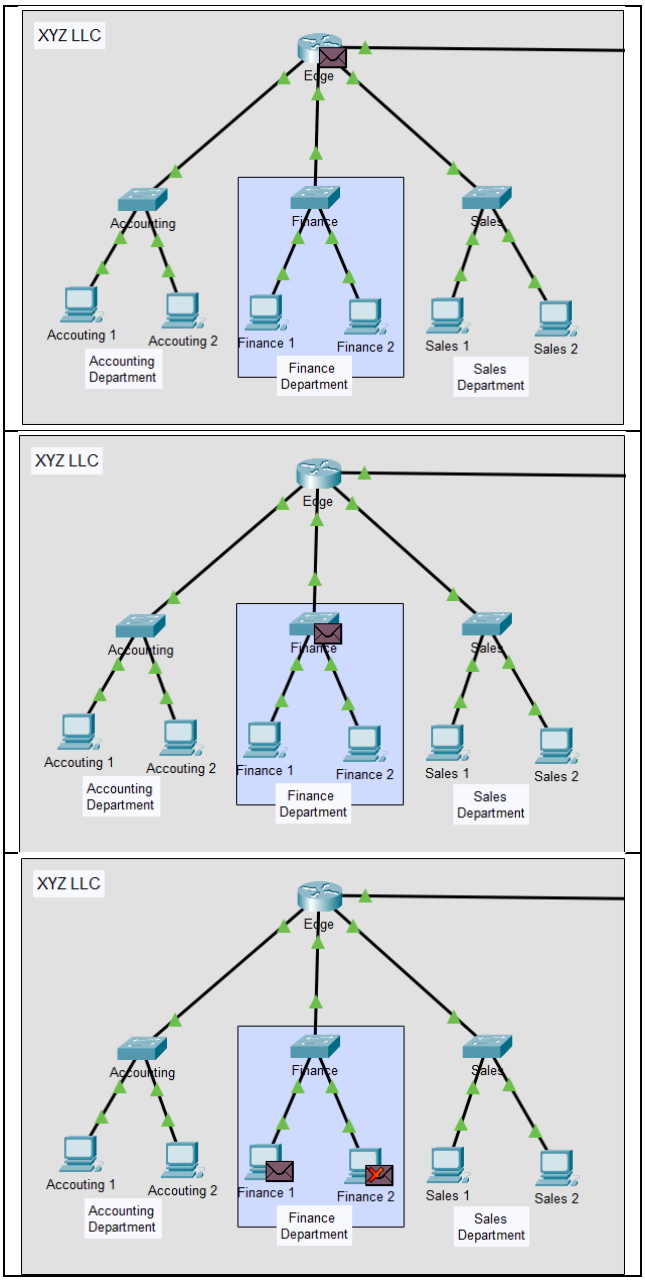


Step 2: Ping Between Different Networks (in Realtime Mode)

1. On Sales1, open Command Prompt and ping Finance1:

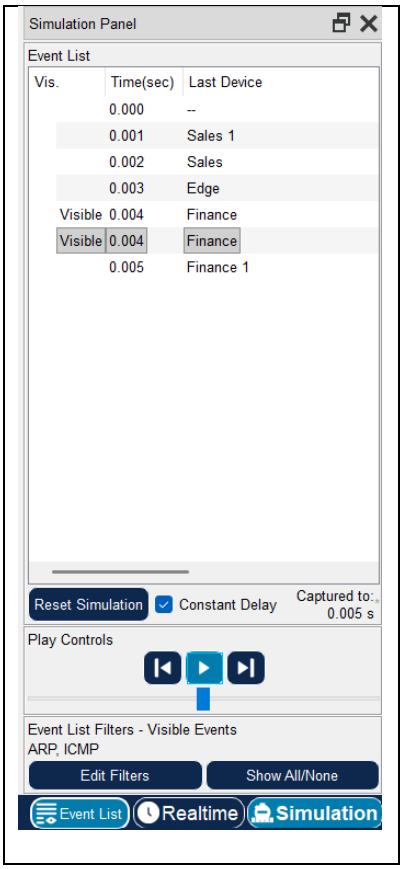






you'll see:

- The ICMP packet leaves Sales1
- Goes through the Sales switch → Router (Edge)
- Router forwards it to Finance switch → Finance1



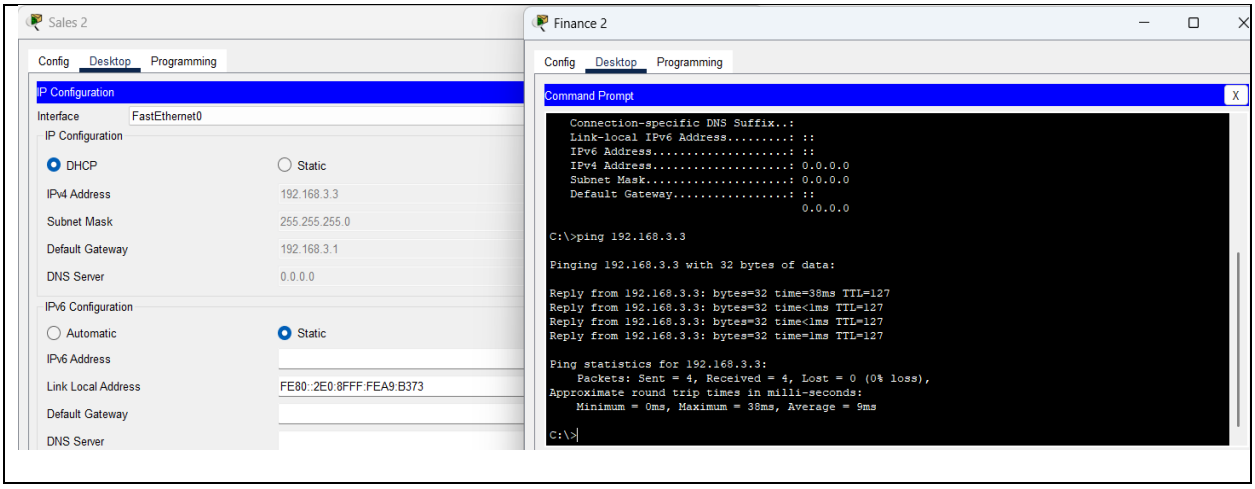
Observation:

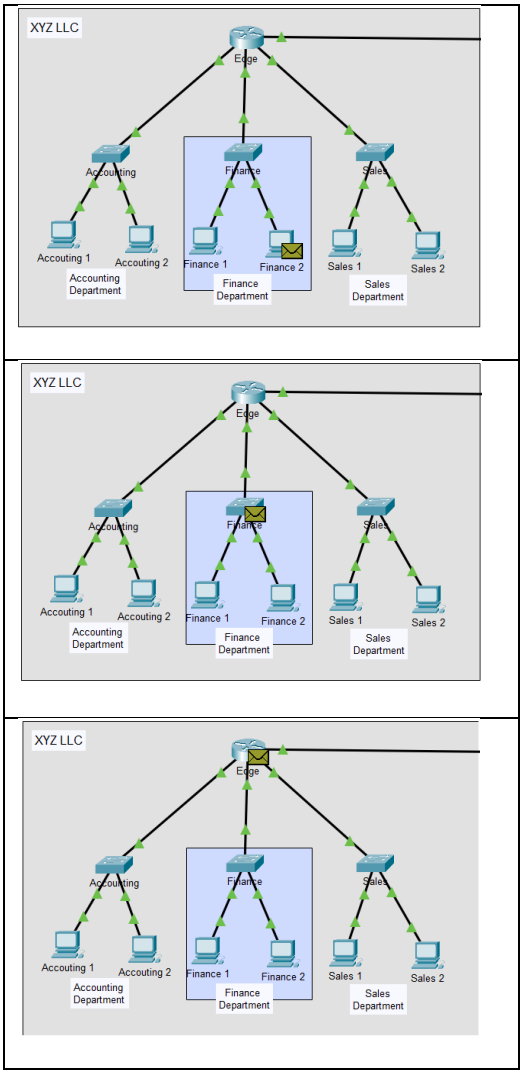
When pinging between networks, packets now pass through the Edge router.

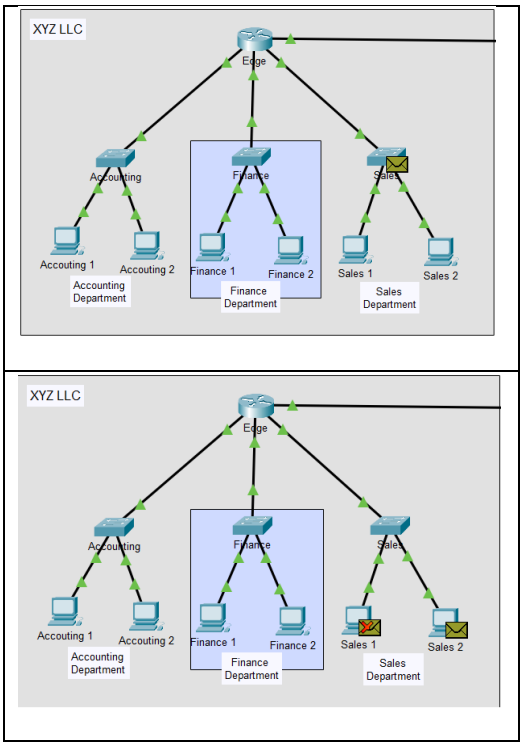
ARP broadcasts stay within their own LAN instead of flooding the entire network, improving efficiency.

The router forwards only necessary traffic to the destination network.

Ping Sales 2 from Finance 2







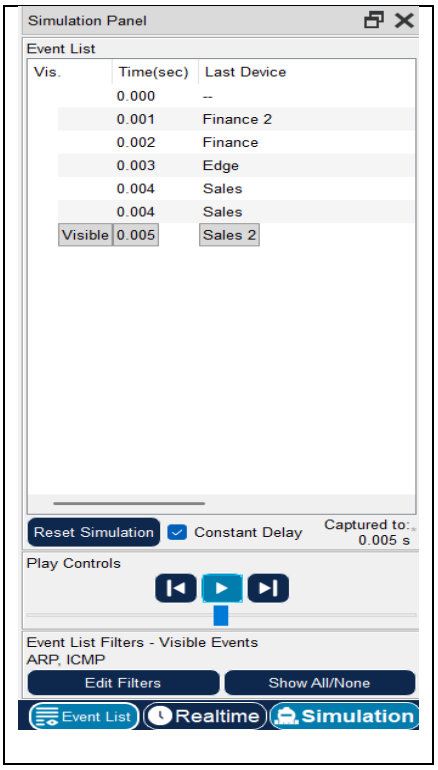
Observation:

When Finance2 pings Sales2, the packet travels from the Finance network to the Sales network through the Edge router.

The ARP request was limited to the Finance LAN, and only the router interface participated in the process.

The ping replies confirm that inter-network routing is functioning correctly.

This demonstrates how routing between subnets allows communication without flooding ARP broadcasts across the entire LAN, increasing network efficiency.



In Simulation Mode, the ARP request from Finance2 was limited to its own LAN and only reached the router's interface. The router then routed the ping packet to the Sales network, where Sales2 responded with an ICMP Echo Reply. The traffic passed only through the router, showing that ARP broadcasts do not cross between subnets and routing allows direct communication between departments.

Question

Which devices receive ARP broadcasts now?

Only devices inside the same LAN subnet (Sales network only).

Broadcasts no longer propagate across the entire company network.

Question

Benefit of using multiple IPv4 subnets?

Reduced broadcast traffic, improved scalability, improved performance, easier network management, stronger security boundaries.

8. Results and Findings

Criteria	Before Routing	After Routing
Broadcast Traffic	High	Reduced
Network Efficiency	Low	Improved
Host Communication	Direct via LAN	Routed via Gateway
Scalability	Poor	Strong

Routing significantly improved performance and created a more scalable network structure.

9. Conclusion

This lab demonstrated the critical role of routing in enterprise networks.

By segmenting the network into multiple subnets:

- Broadcast traffic was reduced.
- Network efficiency and performance improved.
- Traffic paths became controlled and predictable.

Routing is essential as business networks grow.

10. Reflection Questions

Question	Answer
1. What types of cables were used?	Copper straight-through Ethernet cables.
2. Did cables change how PDUs were handled?	No, PDUs are handled the same regardless of copper cabling.
3. Did the Access Point modify PDUs?	No, it only forwards them.
4. Did the Access Point change addressing?	No, it retains original MAC/IP addressing.
5. Highest OSI layer used by AP?	Layer 2 Data Link.
6. Layer at which cables & APs operate?	Layer 1 (Physical) and Layer 2 (Data Link).
7. Which MAC appears first in PDU details?	Destination MAC appears first.
8. Meaning of Red X vs Green ✓?	Red X indicates drop or failure; Green ✓ means successful delivery.
9. Where did MAC addresses change?	At the router, which forwards between networks.
10. Which device uses MACs starting with 00D0:BA?	The router interface.
11. Other MAC addresses belonged to?	End devices (PCs) and switches.
12. Did IPv4 addresses change?	No, only MAC addresses changed.
13. What happens in reply (pong)?	Source and destination swap roles.
14. Why are router interfaces in different networks?	To enable routing between subnets.
15. Which networks are connected?	192.168.1.0/24, 192.168.2.0/24, 192.168.3.0/24, and ISP network.