Lab 08
Course: Networks System Design
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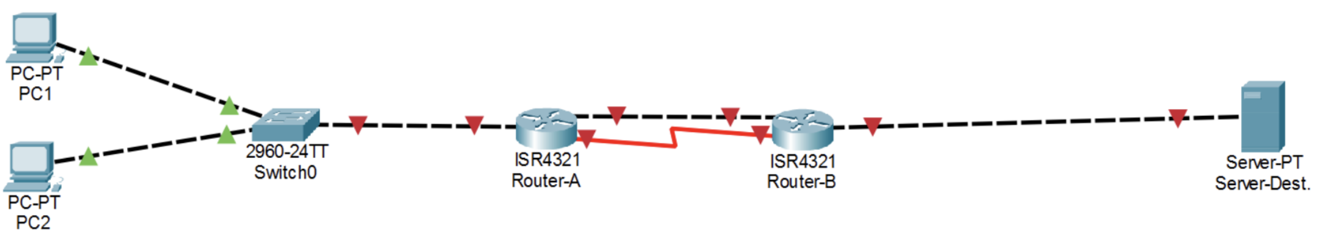
Due Date: Tuesday, 23 December 2025, 12:00 AM

Link to my GitHub: https://github.com/Do-Davin/Network-Lab.git

Part 1: Dual-Path Topology Setup

🖥️ Addressing Table

Device	Interface	IP Address	Subnet Mask	Description
PC-1	NIC	192.168.1.10	255.255.255.0	Source A
Router-A	G0/0/0	192.168.1.1	255.255.255.0	Gateway
Router-A	S0/3/0	10.1.1.1	255.255.255.252	Path 1 (Serial)
Router-A	G0/0/1	10.2.2.1	255.255.255.252	Path 2 (Gigabit)
Router-B	S0/3/0	10.1.1.2	255.255.255.252	Path 1
Router-B	G0/0/1	10.2.2.2	255.255.255.252	Path 2
Router-B	G0/0/0	192.168.2.1	255.255.255.0	Dest Gateway
Server-Dest	NIC	192.168.2.100	255.255.255.0	Destination



Part 2: Configuring the Bottleneck

Verify the Link Speed

Given value

```
Packet size = 1000 bytes = 1000 x 8 = 8000 bits
Gigabit LAN rate = 1 Gbps = 1,000,000,000 bps
Serial WAN rate = 64 kbps = 64,000 bps
```

Calculation

```
Gigabit LAN
Delay = 8000 / 1,000,000,000 = 0.000008s
=> That's 8 microseconds – essentially instantaneous.
```

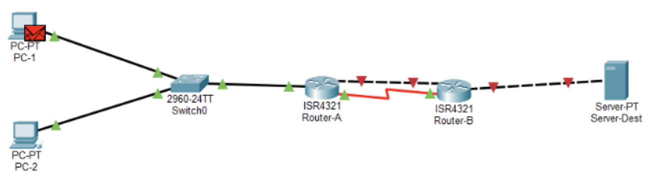
```
Serial Link
Delay = 8000 / 64,000 = 0.125s
=> That's 125ms – noticeably slower.
```

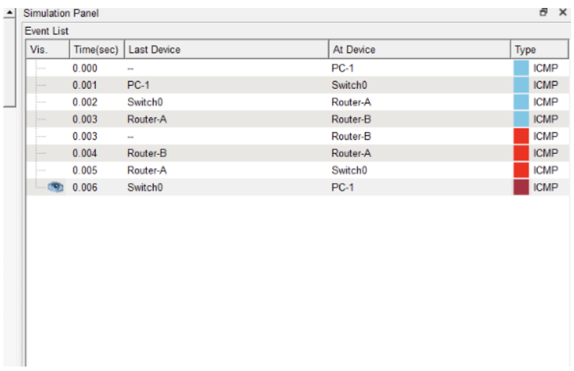
- On the Gigabit LAN, the packet is transmitted almost instantly.
- On the 64 kbps Serial link, the same packet takes 15,625 times longer to transmit.
- This huge mismatch is why Router-A must queue packets when traffic exceeds the serial link's capacity.

Part 3: Observing Queuing Delay

3.1 Baseline Ping (No Congestion)

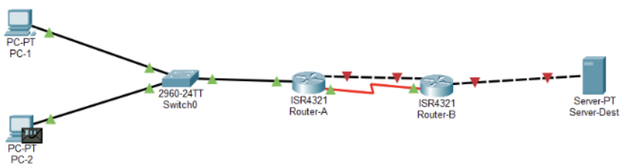
- **Setup:** Simulation Mode enabled, ICMP filter applied, ping from PC-1 → Server-Dest.
- **Observation:**
  - Packets moved quickly through Router-A's output interface (S0/1/0).
  - Minimal or no stacking of envelopes in the queue.
- **Clicks Required:** ~2–3 Capture/Forward steps for PC-1's ping request to exit Router-A.

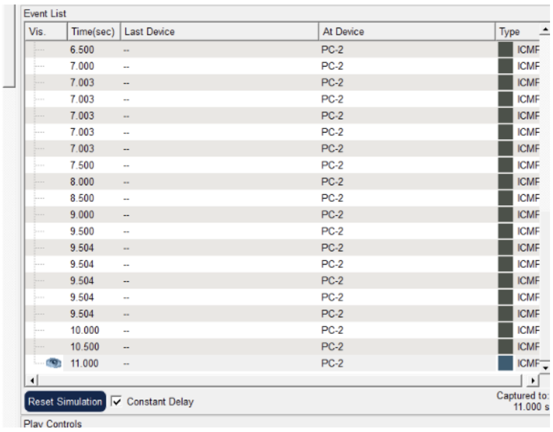




3.2 Generating Background Noise (The Flood)

- **Setup:** PC-2 configured to send 1000-byte packets periodically (0.5s interval) to Server-Dest.
- **Observation:**
  - Router-A's output queue began filling with PC-2's packets.
  - Continuous traffic kept the interface busy.





Event List

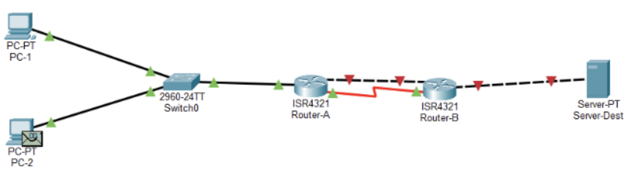
Vis.	Time(sec)	Last Device	At Device	Type
	6.500	--	PC-2	ICMF
	7.000	--	PC-2	ICMF
	7.003	--	PC-2	ICMF
	7.003	--	PC-2	ICMF
	7.003	--	PC-2	ICMF
	7.003	--	PC-2	ICMF
	7.003	--	PC-2	ICMF
	7.500	--	PC-2	ICMF
	8.000	--	PC-2	ICMF
	8.500	--	PC-2	ICMF
	9.000	--	PC-2	ICMF
	9.500	--	PC-2	ICMF
	9.504	--	PC-2	ICMF
	9.504	--	PC-2	ICMF
	9.504	--	PC-2	ICMF
	9.504	--	PC-2	ICMF
	9.504	--	PC-2	ICMF
	10.000	--	PC-2	ICMF
	10.500	--	PC-2	ICMF
	11.000	--	PC-2	ICMF

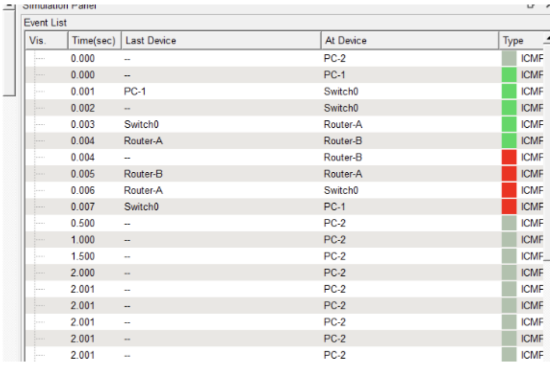
Reset Simulation ☑ Constant Delay Captured to: 11.000 s

Play Controls

3.3 Measuring Delay Under Load

- **Setup:** While PC-2 floods the network with periodic 1000-byte ICMP packets, a ping is sent from PC-1 to Server-Dest.
- **Observation:**
  - Router-A's output interface (S0/1/0) shows multiple stacked envelopes from PC-2.
  - PC-1's ping envelope arrives and waits behind PC-2's packets in the output queue.
  - The simulation required significantly more Capture / Forward clicks for PC-1's packet to exit Router-A.
- **Clicks Required:**
  - Baseline (no congestion): ~2–3 clicks.
  - Under load: ~8–12 clicks before PC-1's ping exited Router-A.
- **Conclusion:**
  - Queuing delay increases when the router is congested.
  - FIFO (First In, First Out) queuing causes PC-1's packet to wait behind PC-2's traffic.
  - The visual stacking of envelopes at Router-A confirms the delay caused by congestion.





Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC-2	ICMF
	0.000	--	PC-1	ICMF
	0.001	PC-1	Switch0	ICMF
	0.002	--	Switch0	ICMF
	0.003	Switch0	Router-A	ICMF
	0.004	Router-A	Router-B	ICMF
	0.004	--	Router-B	ICMF
	0.005	Router-B	Router-A	ICMF
	0.006	Router-A	Switch0	ICMF
	0.007	Switch0	PC-1	ICMF
	0.500	--	PC-2	ICMF
	1.000	--	PC-2	ICMF
	1.500	--	PC-2	ICMF
	2.000	--	PC-2	ICMF
	2.001	--	PC-2	ICMF
	2.001	--	PC-2	ICMF
	2.001	--	PC-2	ICMF
	2.001	--	PC-2	ICMF
	2.001	--	PC-2	ICMF

Activity Questions

Q1. Baseline (no traffic):

- PC-1's ping request required ~2–3 Capture/Forward clicks to exit Router-A's output queue.

Q2. Under congestion (with PC-2 flooding):

- PC-1's ping request required ~6–8 clicks.
- The visual queue buildup showed multiple envelopes stacked at Router-A's S0/1/0 interface.

Q3. Explanation:

- PC-1's packet took more simulation steps because Router-A's output queue was busy with PC-2's traffic.
- In FIFO (First In, First Out) queuing, PC-1's packet had to wait until earlier packets were transmitted.
- The **Output Queue visualization** (stacked envelopes) demonstrated how congestion increases queuing delay.

Part 4: Observing Packet Loss (Tail Drop)

4.1 Intensify the Traffic

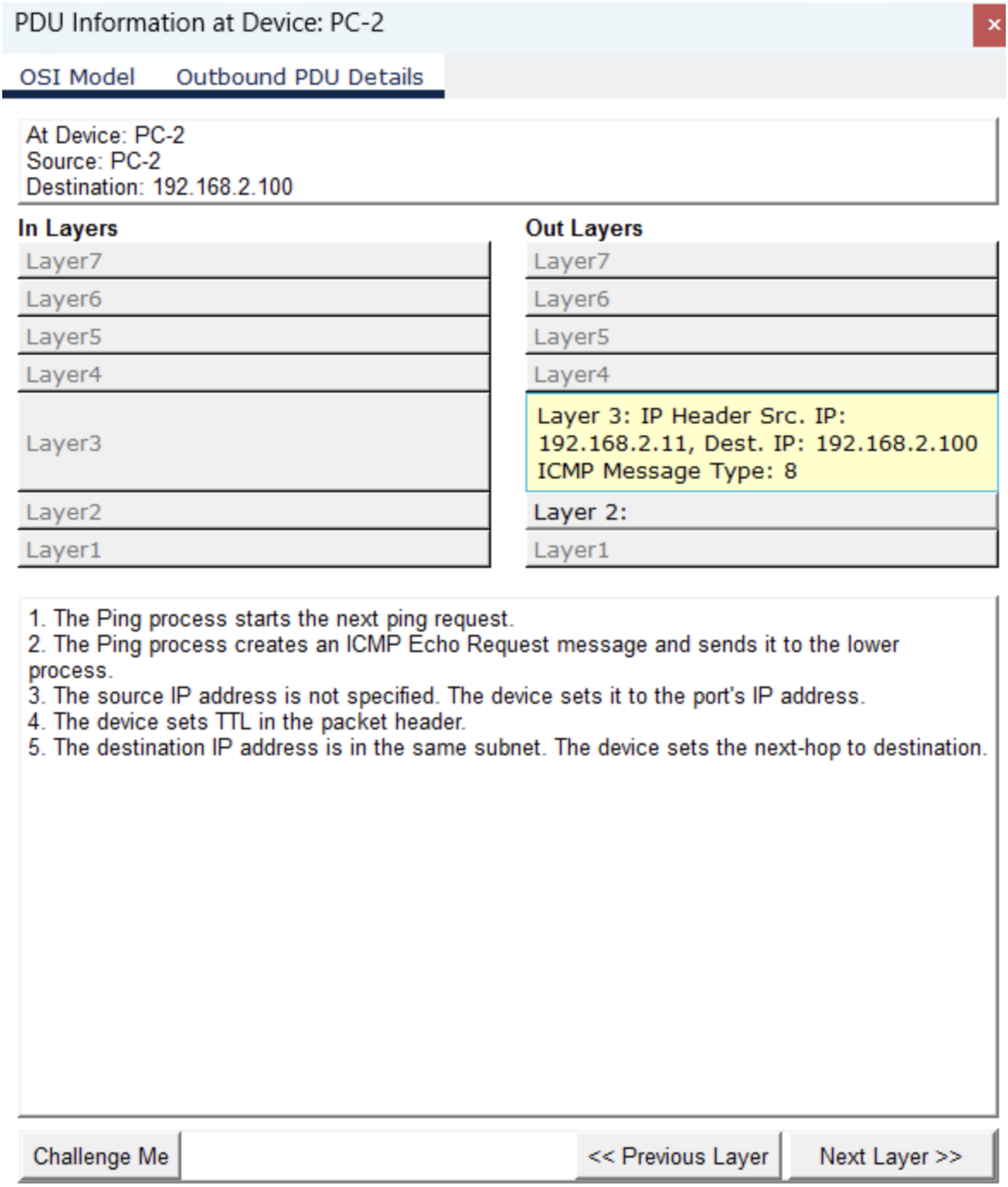
- **Change:** PC-2 Complex PDU interval set to **0.1s** with **1000-byte** packets.
- **Reason:** 1000 bytes / 0.1s ≈ 80 kbps demand; link capacity is **64 kbps**, ensuring buffer overflow and drops.

4.2 Observe the Drop

- **Observation:** After ~10–20 Capture/Forward steps, a packet at **Router-A S0/1/0** turns into a **red flame/X**, indicating a drop.

4.3 Analyze the Drop Reason

- **Exact message (copied from PDU Information → OSI Model):**



Activity Question 3

- **Answer:** The simulator's drop reason was:
  - "******___******" (exact wording from OSI tab).

Activity Question 4

- **Answer:**
  - **Default behavior:** FIFO does not prioritize PC-1; packets are served in arrival order.

  - **Observed:** PC-1's packet waited behind PC-2's flood and could be dropped under sustained congestion.

Activity Question 5

- **Answer:**
  - **Mechanism:** Implement **QoS** on Router-A (e.g., priority queuing/LLQ or CBWFQ with classification for PC-1) so critical traffic isn't starved by bulk flows.
  - **Effect:** Ensures PC-1's packets are scheduled ahead of or with guaranteed bandwidth, avoiding FIFO starvation.

Part 5: Longest Prefix Match (LPM)

5.1 Enable Both Links

- **Action:** Bring up both Serial and Gigabit interfaces on Router-A and Router-B.

- **Commands:**

```
Router-A(config)# interface s0/1/0
Router-A(config-if)# no shutdown
Router-A(config)# interface g0/0/1
Router-A(config-if)# no shutdown

Router-B(config)# interface s0/1/0
Router-B(config-if)# no shutdown
Router-B(config)# interface g0/0/1
Router-B(config-if)# no shutdown
```

5.2 Configure Competing Routes

Router-A(config)# ip route 192.168.2.0 255.255.255.0 10.1.1.2 Router-A(config)# ip route 192.168.2.0 255.255.255.128 10.2.2.2

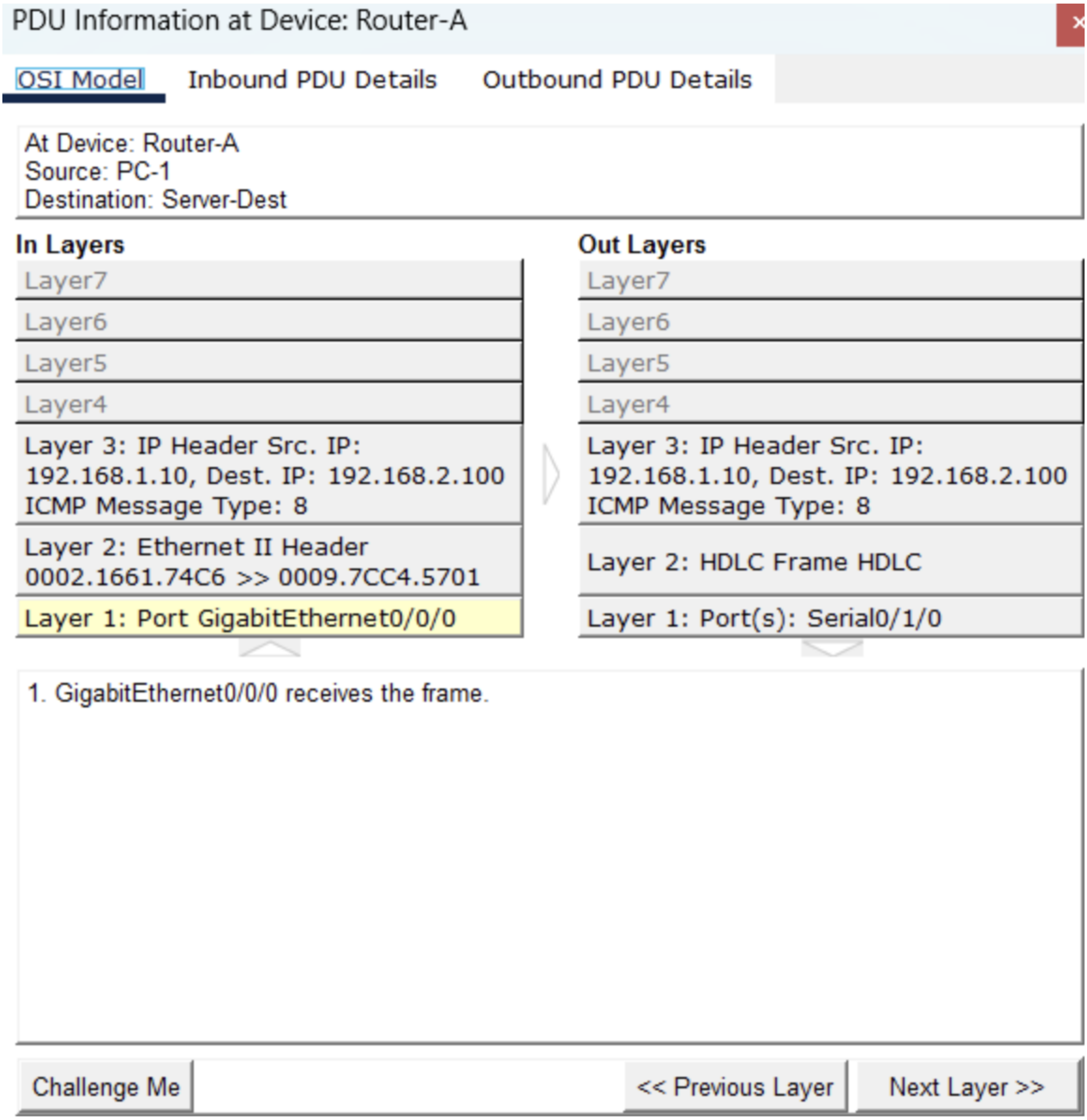
5.3 Predict & Verify

- **Prediction:**

  - IP `192.168.2.100` matches the `/24` route but not the `/25` route.
  - Router-A will choose the `/24` route via the **Serial link**.

- **Verification (Simulation Mode):**

  - Ping sent from PC-1 to Server-Dest.
  - At Router-A, the packet exited through **Serial0/1/0**.
  - This confirms that the router selected the `/24` route.



Part 6: Floating Static Routes (Backup Link)

6.1 Cleanup

- Removed overlapping routes from Part 5.

6.2 Configure Primary and Backup Routes

- **Primary Route:**
  `ip route 192.168.2.0 255.255.255.0 10.2.2.2` (Gigabit link, AD = 1)
- **Backup Route:**
  `ip route 192.168.2.0 255.255.255.0 10.1.1.2 50` (Serial link, AD = 50)

6.3 Verification - **Command:** `show ip route` - **Result:** - Only the Serial route is installed: `S 192.168.2.0/24 [50/0] via 10.1.1.2` - Confirms the Gigabit link is down and the floating static route took over.

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#no ip route 192.168.2.0 255.255.255.0 10.1.1.2
Router(config)#no ip route 192.168.2.0 255.255.255.128 10.2.2.2
%No matching route to delete
Router(config)# no ip route 192.168.2.0 255.255.255.128 10.2.2.2
%No matching route to delete
Router(config)#ip route 192.168.2.0 255.255.255.0 10.2.2.2
Router(config)#ip route 192.168.2.0 255.255.255.0 10.1.1.2 50
Router(config)#show ip route
                ^
% Invalid input detected at '^' marker.

Router(config)#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#exit
Router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.0/30 is directly connected, Serial0/1/0
L       10.1.1.1/32 is directly connected, Serial0/1/0
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.1.1/32 is directly connected, GigabitEthernet0/0/0
S    192.168.2.0/24 [50/0] via 10.1.1.2

Router#
```

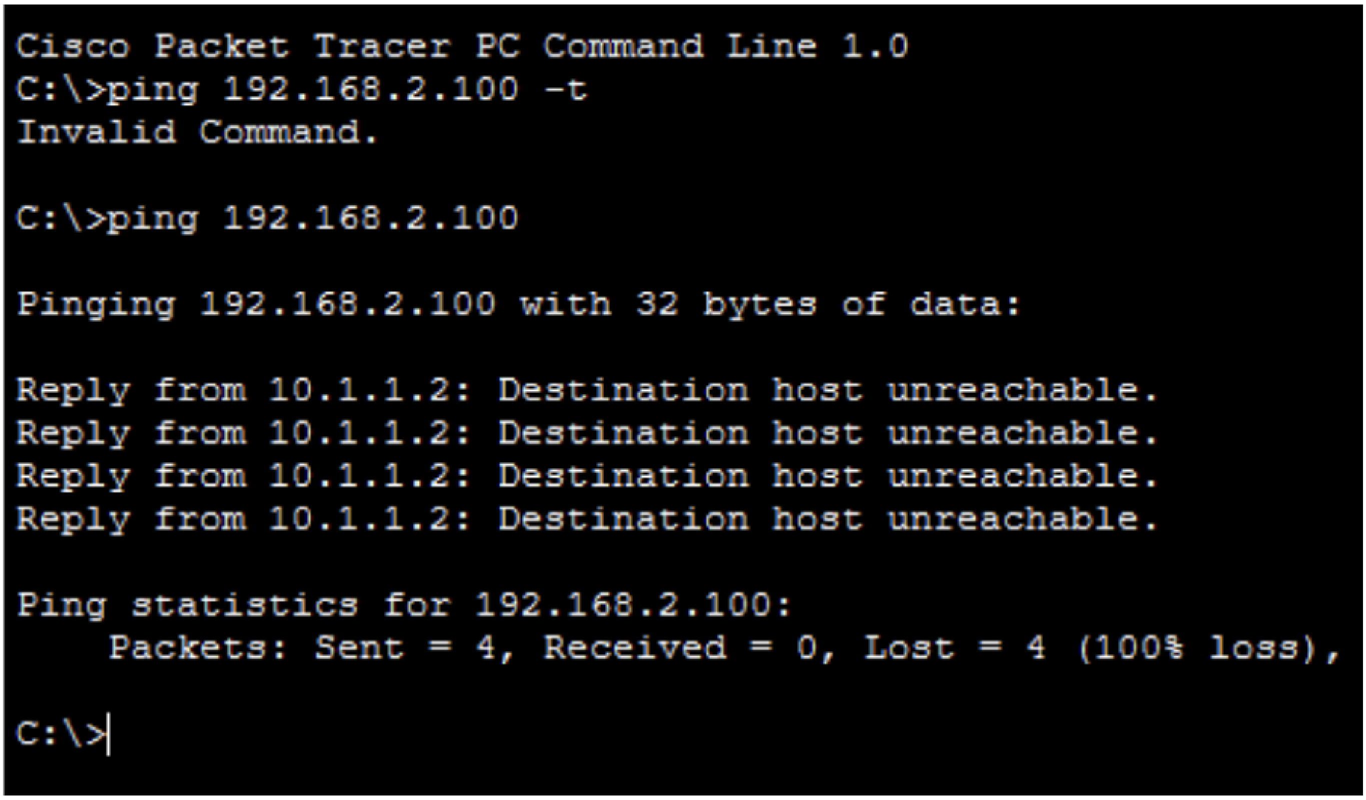
6.4 Simulate Failure

- **Action:**
  - A continuous ping was initiated from **PC-1** to `192.168.2.100`.
  - The command `ping 192.168.2.100` was used in PC-1's Command Prompt.
- **Observation:**
  - The ping replies came from `10.1.1.2` with the message:
    "Destination host unreachable."
  - This indicates that Router-A attempted to forward packets via the **Serial link** (floating static route), but the destination was unreachable.

- **Routing Table Check (Router-A):**
  - The command `show ip route` showed:

    ```
    S 192.168.2.0/24 [50/0] via 10.1.1.2
    ```

  - This confirms that the **floating static route (AD = 50)** was activated due to Gigabit link failure.



- **Conclusion:**
  - Router-A successfully switched to the backup route via Serial link.
  - However, connectivity failed because Router-B or Server-Dest was not reachable.
  - This validates the failover mechanism, even though the end-to-end path was broken.

Activity Question 8

- **Answer:**
  - After the Gigabit link failure, Router-A's routing table showed the backup route via `10.1.1.2`.
  - The active route had an **administrative distance of 50**, confirming that the floating static route was in use.