ENCS5121
Information Security and
Computer Networks Laboratory

EXPERIMENT #8
ICMP Redirect Attack Lab

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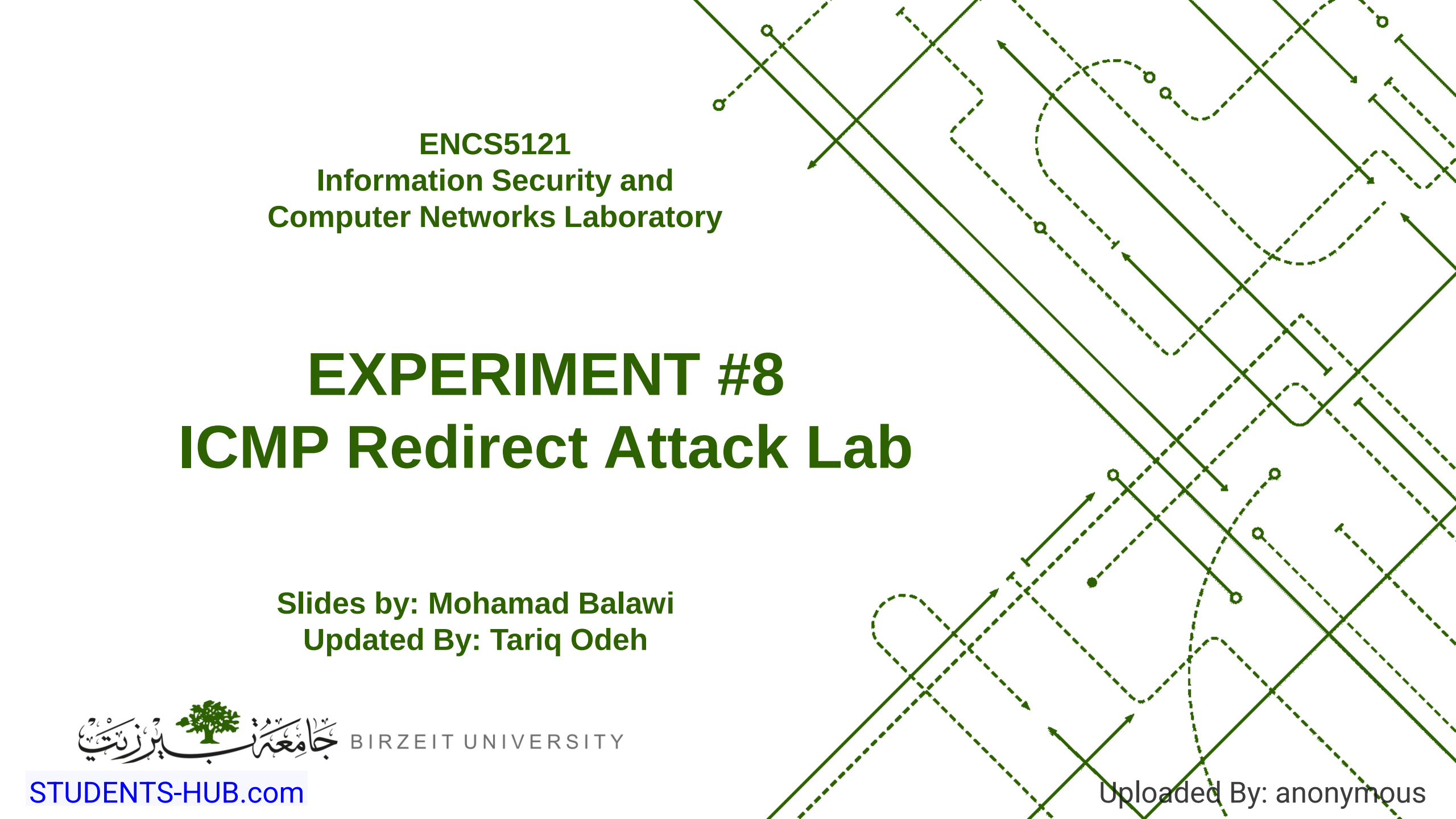

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Overview

- **Problem:**
  - ICMP Redirect attacks manipulate routing to redirect victim traffic through a malicious router, enabling packet interception and modification.
- **Solution:**
  - Secure network configurations prevent unauthorized ICMP redirects and mitigate MITM risks.
- **Key Components:**
  - ICMP Protocol: Handles error and control messages.
  - Routing Table: Targeted by attackers to alter packet paths.
- **Applications:**
  - Demonstrates routing vulnerabilities.
  - Highlights the need for secure configurations against ICMP-related threats.

Outline

- **Introduction**
- **Task 1:** Launching ICMP Redirect Attack
  - Question 1
  - Question 2
  - Question 3
- **Task 2:** Launching the MITM Attack
  - Question 4
  - Question 5

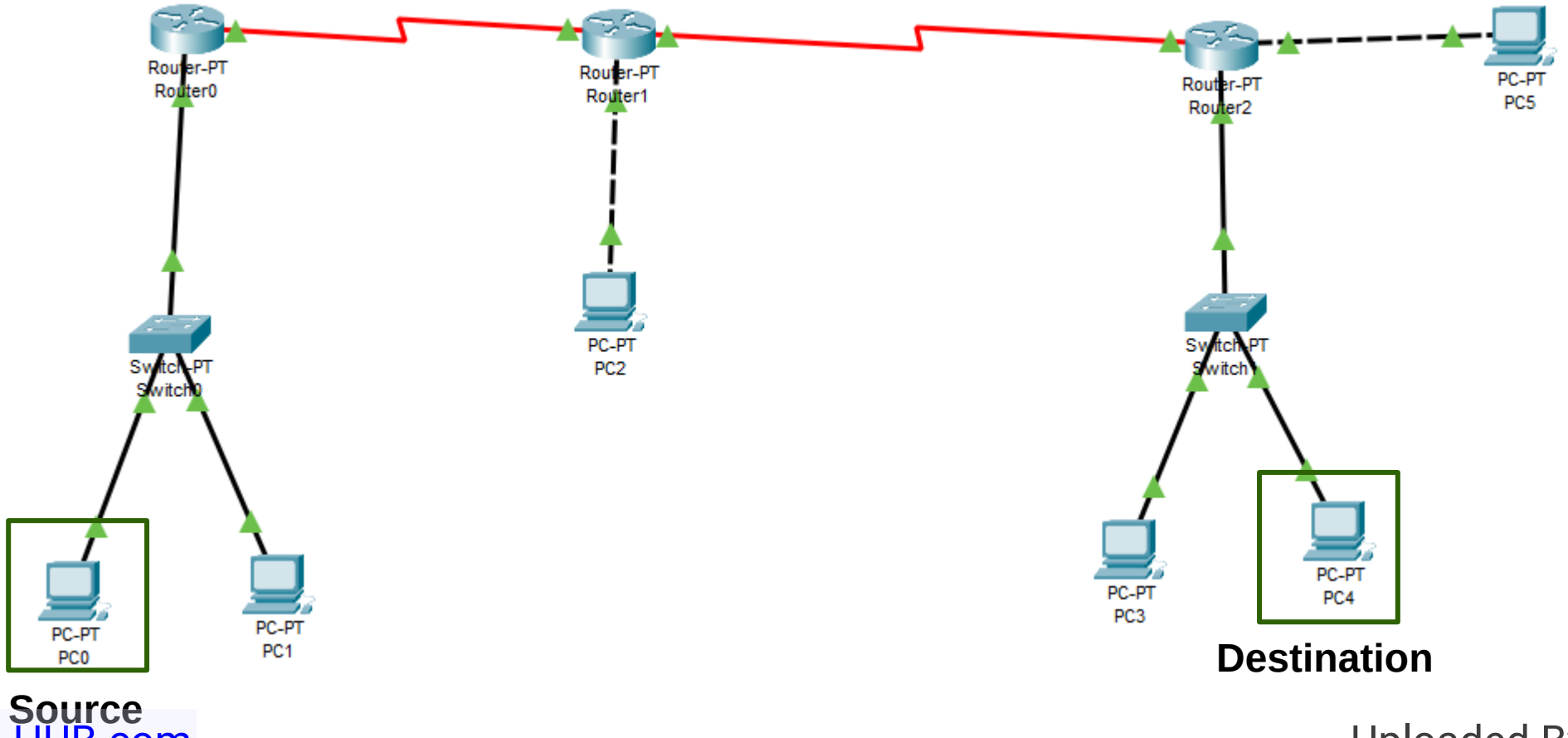
Internet Control Message Protocol (ICMP)

- **Overview:**
  - ICMP is a network layer protocol used for diagnosing communication issues, ensuring data reaches its destination, and reporting errors.

- **Common Uses:**
  - **Ping**: Sends echo requests to test connectivity and measures response times.
  - **Traceroute**: Maps the path packets take, using TTL values and Time Exceeded messages.

- **Significance:**
  - ICMP is essential for error reporting and network testing but can be exploited in DDoS attacks.

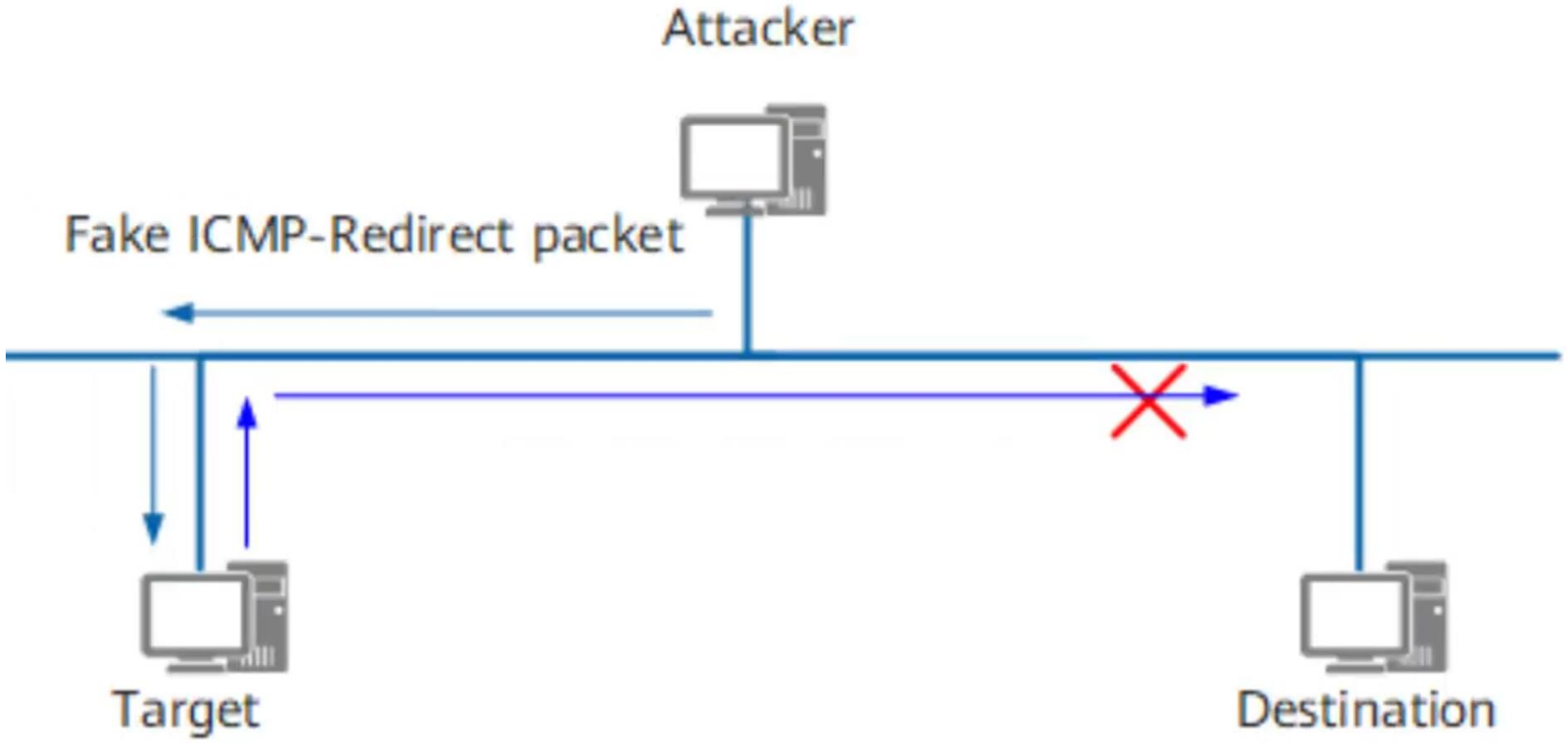
Internet Control Message Protocol (ICMP) Cont.



ICMP Redirect Message

- **Overview:**
  - An ICMP Redirect is an error message sent by a router to inform the sender that packets should be routed through a different router.
- **Purpose:**
  - To correct routing when a packet is being sent through an inefficient path.
- **Security Concern:**
  - Attackers can exploit ICMP Redirects to manipulate routing and launch Man-in-the-Middle (MITM) attacks.

ICMP Redirect Attack



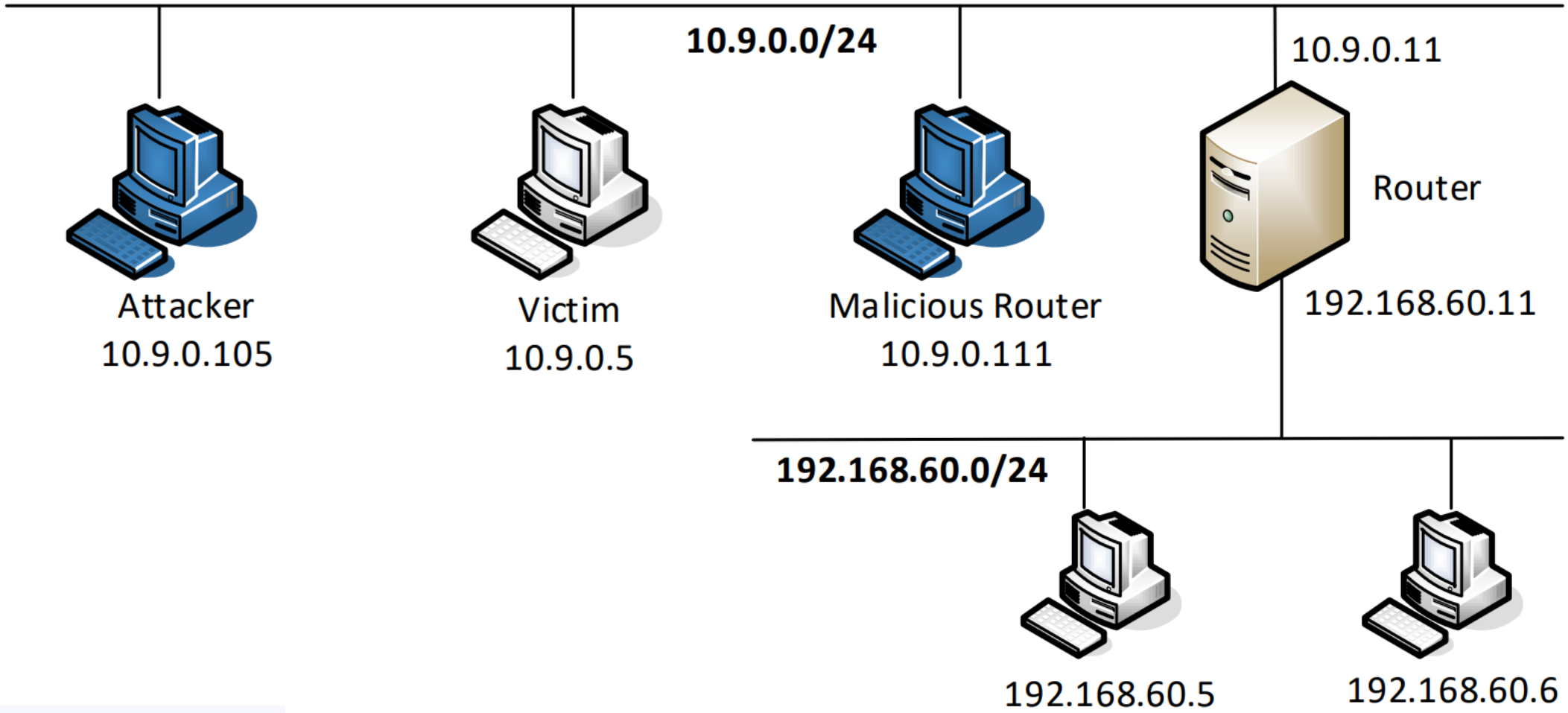
Traceroute vs. MTR

- **Traceroute:** Static View
  - Sends packets with increasing TTL values to map the path to a destination.
  - Receives ICMP Time Exceeded messages from routers to identify each hop.

- **MTR:** ping + traceroute
  - Combines Traceroute and Ping functionalities.
  - Continuously pings each hop along the route.
  - Provides real-time statistics on packet loss and latency for each hop.

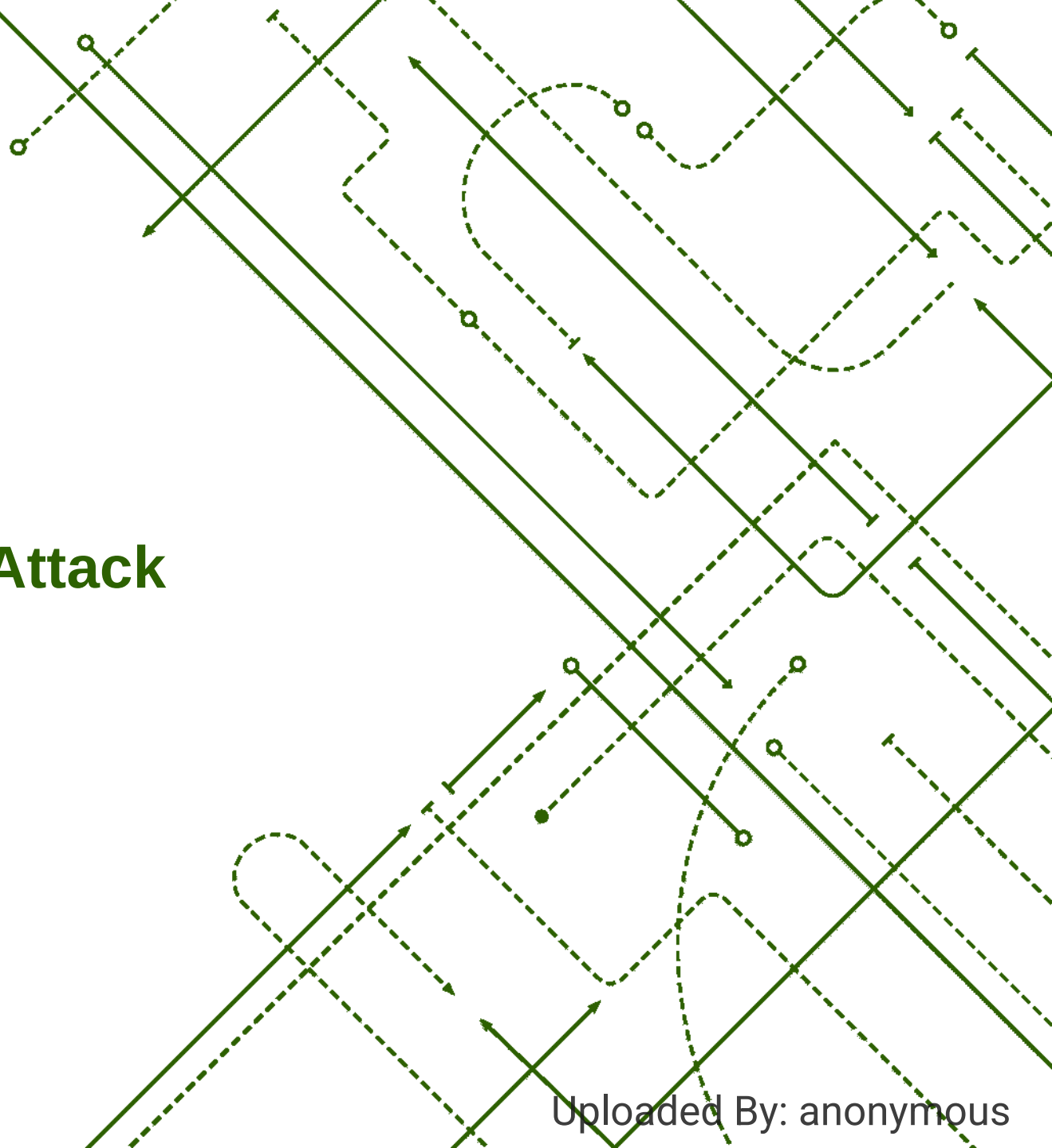
- **Key Benefit of MTR:**
  - Offers detailed, ongoing network performance insights beyond the static view of traceroute.

Lab Setup



TASK1

Launching ICMP Redirect Attack



Task 1: Launching ICMP Redirect Attack

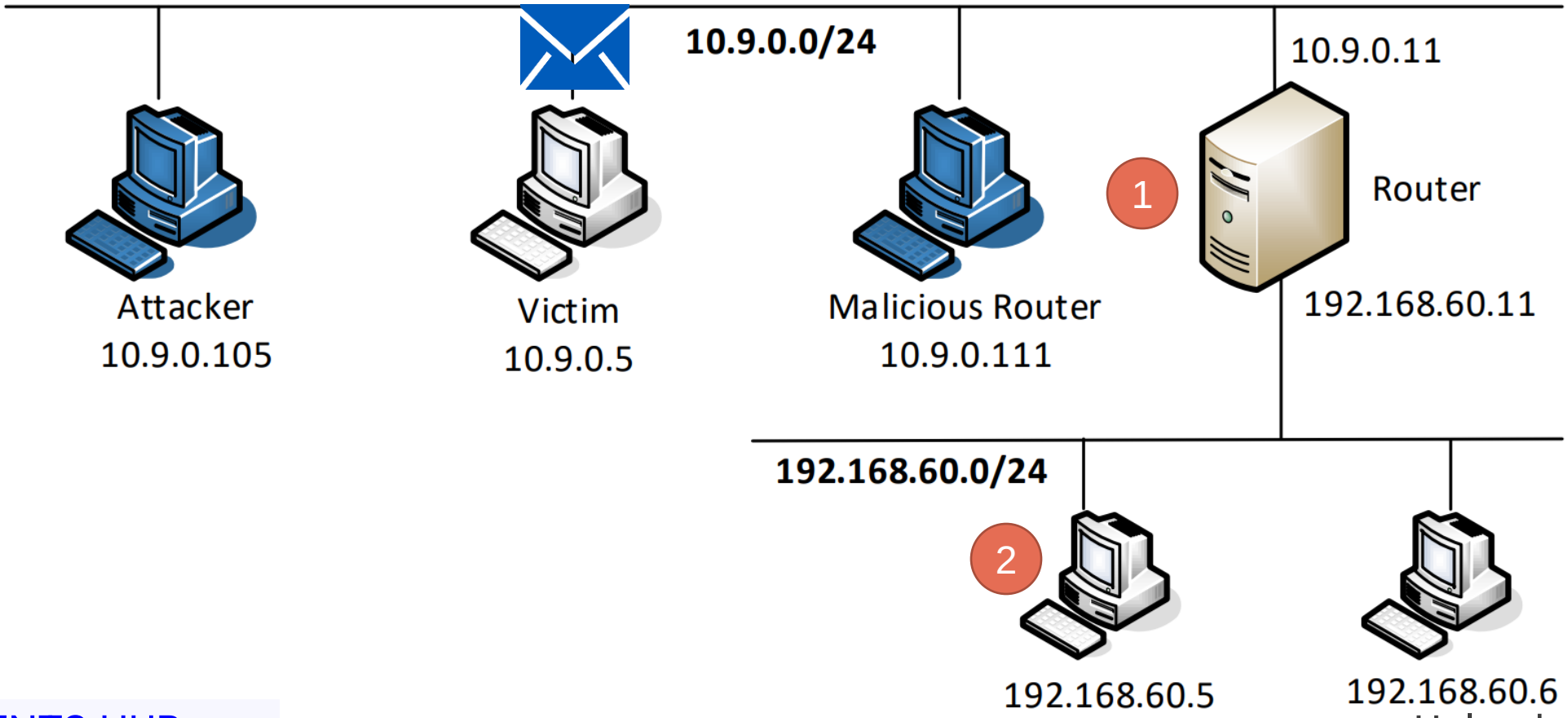
- For this task, we will attack the victim container from the attacker container.
- In the current setup, the victim will use the router container (192.168.60.11) as the router to get to the 192.168.60.0/24 network. If we run ip route on the victim container, we will see the following:

```
root@3f1b879f0ae8:/# ip route
```

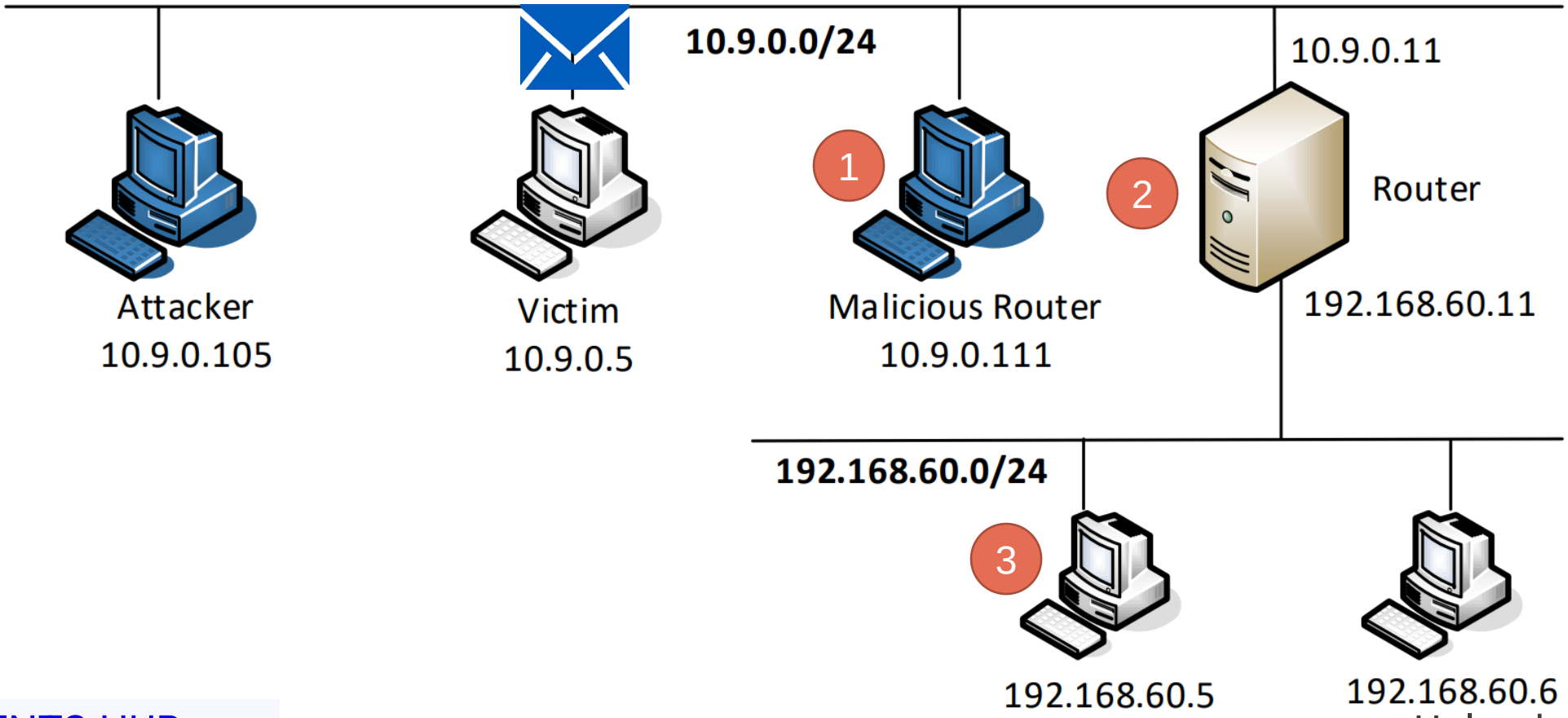
Output:

```
default via 10.9.0.1 dev eth0
10.9.0.0/24 dev eth0 proto kernel scope link src 10.9.0.5
192.168.60.0/24 via 10.9.0.11 dev eth0
```

Expected Packet Path



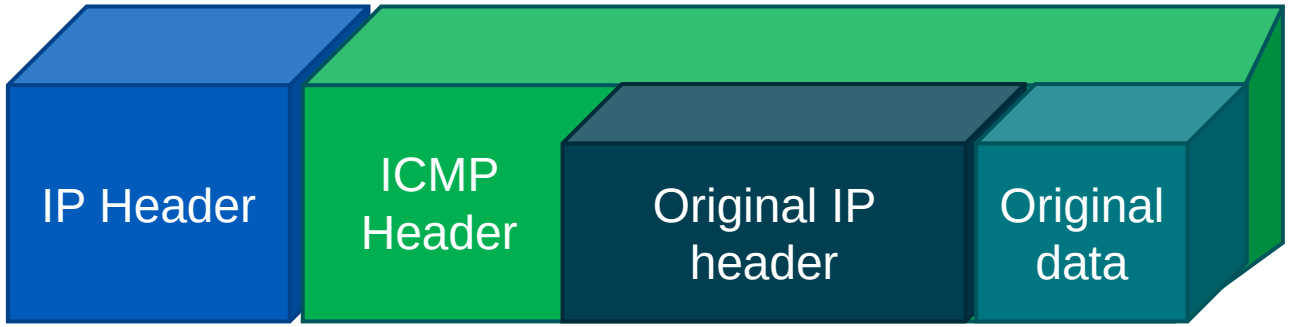
The Actual Packet Path After the Attack



ICMP Redirect Message Structure

The ICMP redirect message consists of 4 main components:

1. IP Header: contains the target and source IPs.
2. ICMP Header: contains the information needed for the redirection such as the correct gateway and the ICMP type and code.
3. Original IP Header: represents the original IP header that was sent.
4. Original Data: represents the original request by the sender.



Scapy Code Snippet

- A code skeleton is provided in the following, with some of the essential parameters left out. Students should fill in the proper values in the places marked by @@@@.

```
#!/usr/bin/python3
from scapy.all import *

ip = IP(src=@@@@, dst=@@@@)
icmp = ICMP(type=@@@@, code=@@@@)
icmp.gw = @@@@
# The enclosed IP packet should be the one that triggers the redirect message.
ip2 = IP(src=@@@@, dst=@@@@)
send(ip/icmp/ip2/ICMP())
```

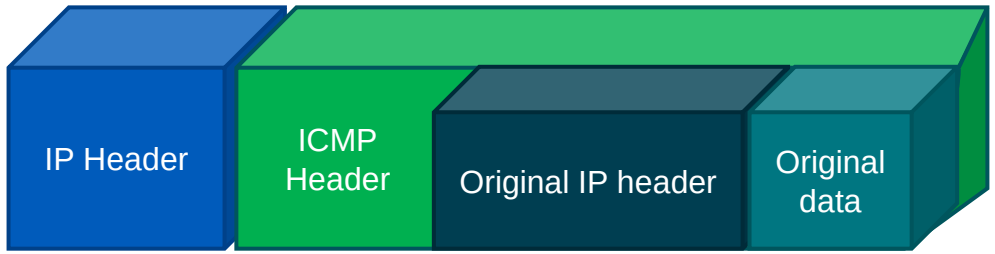
More Information About the Code Snippet

ICMP Type	Message
0	Echo reply
3	Destination unreachable
4	Source quench
5	Redirect
8	Echo
9	Router advertisement
10	Router selection
11	Time exceeded
12	Parameter problem
13	Timestamp
...	...

ICMP Code	Message
0	Net is unreachable
1	Host is unreachable
2	Protocol is unreachable
3	Port is unreachable
4	Fragmentation is needed
5	Source route failed
6	Destination network is unknown
7	Destination host is unknown
8	Source host is isolated
9	Communication is prohibited
...	...

More Information About the Code Snippet

- `ICMP.gw`
  - gw Stands for "gateway".
  - It specifies the IP address of the new gateway (router) that the sender should use for the specified destination network.
- `send( ip/icmp/ip2/ICMP() )`
  - Corresponds to the following ICMP message structure:



Our Goal

- identity and, we need to execute the following command before our attack and take a screenshot:

```
root@Victim:/# mtr -n 192.168.60.5
```

- After that we need to constantly ping the target host form our victim container:

```
root@Victim:/# ping 192.168.60.5 > log.txt
```

- Then we need to modify the code snippet to help the attacker impersonate the router's identity and tell the victim that its last attempt should be redirected to the malicious router.
- Then execute the code inside the attacker container.
- Execute mtr command again, observe the difference, and take a screenshot:

```
root@Victim:/# mtr -n 192.168.60.5
```

Question 1

- Before proceeding we need to flush the routing cache:

```
root@Victim:/# ip route flush cache
```

- Can you use ICMP redirect attacks to redirect to a remote machine? Namely, the IP address assigned to `icmp.gw` is a computer not on the local LAN. Please show your experiment result and explain your observation.

Question 2

- Before proceeding we need to flush the routing cache:

```
root@Victim:/# ip route flush cache
```

- Can you use ICMP redirect attacks to redirect to a non-existing machine on the same network? Namely, the IP address assigned to `icmp.gw` is a local computer that is either offline or non-existing. Please show your experiment result and explain your observation.

Question 3

- Before proceeding we need to flush the routing cache:

```
root@Victim:/# ip route flush cache
```

- If you look at the **docker-compose.yml** file, you will find the following for the malicious router container:

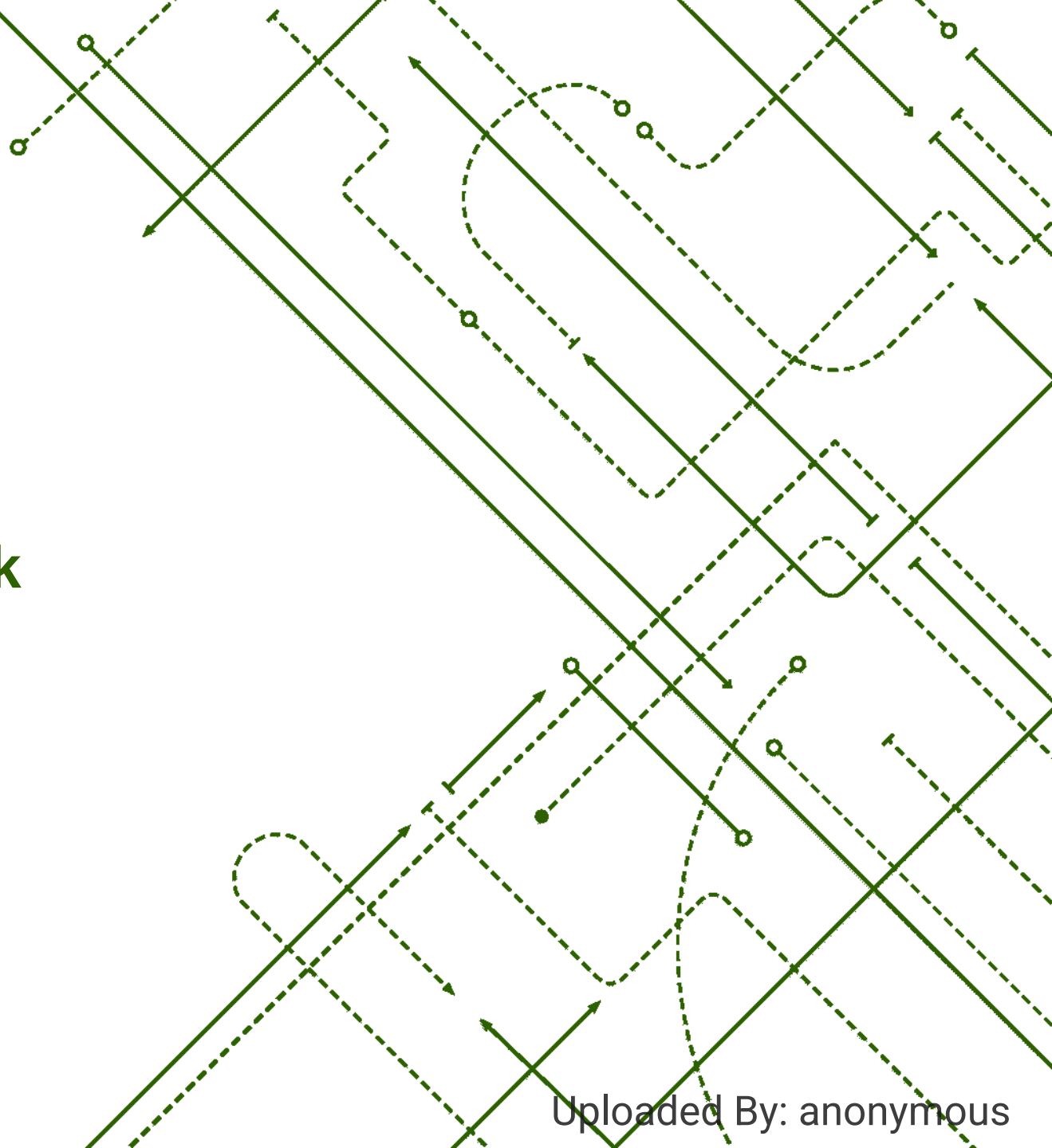
```
sysctls:
    - net.ipv4.conf.all.send_redirects=0
    - net.ipv4.conf.default.send_redirects=0
    - net.ipv4.conf.eth0.send_redirects=0
```

0 => protection is on
1 => protection is off

- What are the purposes of these entries? Please change their value to **1** and launch the attack again. Please describe and explain your observation.

TASK2

Launching the MITM Attack



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Task 2: Launching the MITM Attack

- Using the ICMP redirect attack, we can get the victim to use our malicious router (10.9.0.111) as the router for the destination 192.168.60.5. Therefore, all packets from the victim machine to this destination will be routed through the malicious router. We would like to modify the victim's packets. Before launching the MITM attack, we start a TCP client and server program using netcat. See the following commands.

- On the destination container 192.168.60.5, start the netcat server:

```
root@DestinationContainer:/# nc -lp 9090
```

- On the victim container, connect to the server:

```
root@Victim:/# nc 192.168.60.5 9090
```

IP forwarding on Hosts

- IP forwarding on hosts refers to the capability of a computer to forward network packets between its network interfaces. In typical networking setups, hosts (computers) have multiple network interfaces, such as Ethernet, Wi-Fi, or virtual interfaces. When IP forwarding is enabled on a host, it allows the host to act as a simple router, forwarding packets between these interfaces.

- We need to disable IP forwarding on the malicious router:

```
sysctls:
    - net. ipv4.ip_forward=0
```

Man in the Middle (MITM) Code

- Once the IP forwarding is disabled, our program needs to take over the role of packet forwarding from the victim to the target, of course after making changes to the packets.
- Since the packet's destination is not for us, the kernel will not give the packet to us; it will simply drop the packet. However, if our program is a sniffer program, we will get the packet from the kernel. Therefore, we will use the sniff and-spoof technique to implement this MITM attack. In the following, we provide a sample sniff-and-spoof program, which captures TCP packets, makes some changes, before sending them out.
- **You can find the code from the lab setup files. (Run it in the Malicious Container)**

Question 4

- In your MITM program, you only need to capture the traffics in one direction. Please indicate which direction and explain why.

Question 5

- In the MITM program, when you capture the nc traffics from A (10.9.0.5), you can use A's IP address or MAC address in the filter. One of the choices is not good and is going to create issues, even though both choices may work. Please try both and use your experiment results to show which choice is the correct one, and please explain your conclusion.