Computer Security Capstone

Project II: MITM and Pharming Attacks in Wi-Fi Networks

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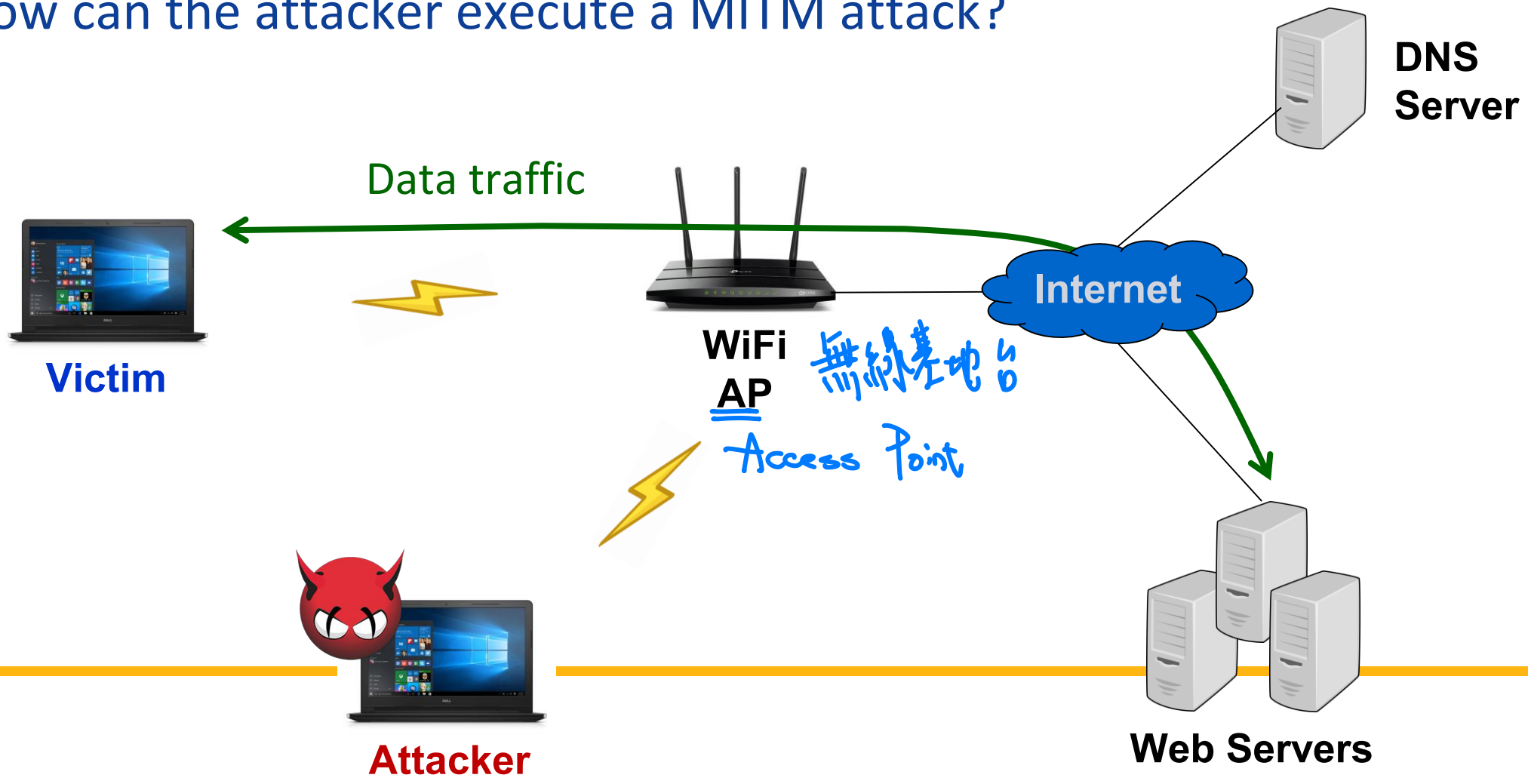
Goal

- Understand how user can be phish by a man-in-the-middle (MITM) attack over Wi-Fi networks

- You will learn how to
  - scan IP/MAC addresses of the devices in a Wi-Fi network
  - launch a man-in-the-middle (MITM) attack by using ICMP redirect
  - launch a pharming attack

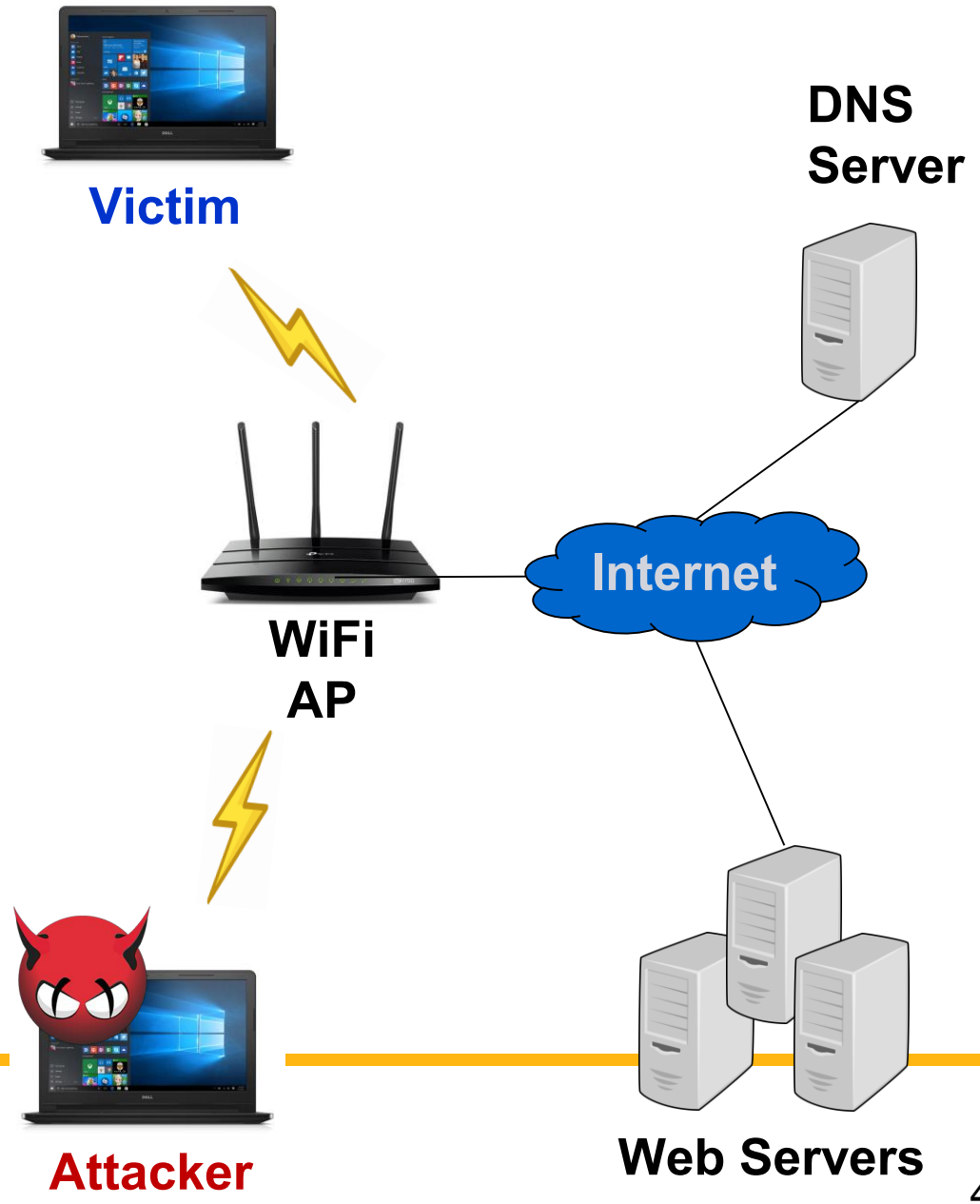
Attack Scenario

- How can the attacker execute a MITM attack?



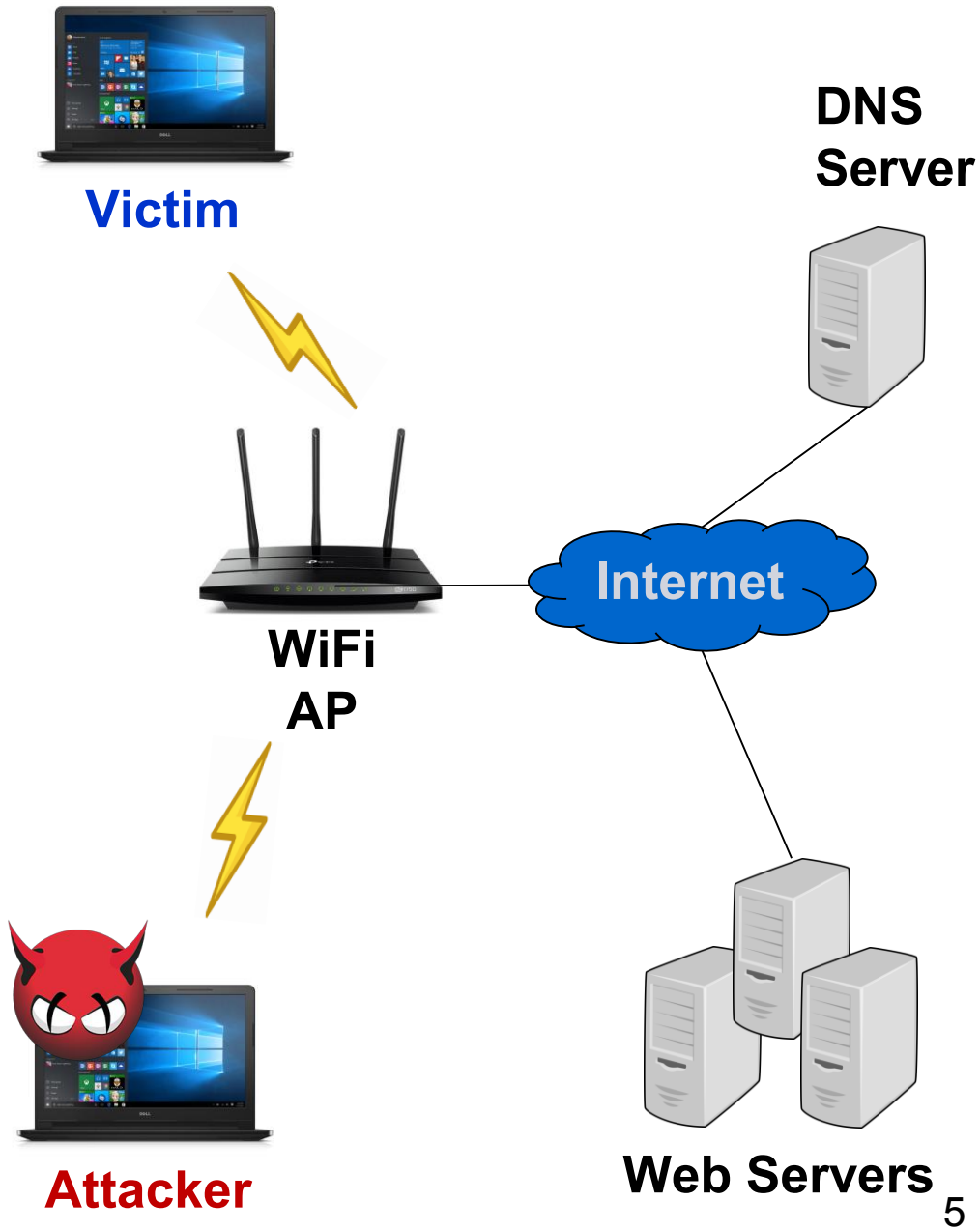
Major Ideas

- Identify the Victim
  - Device Address Information Collection
- Redirect Victim Traffic
  - ICMP redirect attack
- Launch Pharming Attack
  - DNS Spoofing



Tasks: MITM and Pharming

- Device Address Information Collection (Task I: 20%)
  - Obtain all other client devices' IP/MAC addresses in a connected Wi-Fi network
- ICMP redirect attack (Task II: 30%)
  - ICMP redirect for specific client device in the Wi-Fi network
- DNS Spoofing (Task III: 30%)
  - DNS spoofing attack for web services
- Some implementation question during the demo (20%)



Task I: Device Address Information Collection

- Scan all the devices' IP/MAC addresses in the Wi-Fi network
  - Hint: ARP format and raw socket.
- Fetch the IP/MAC addresses of all the other client devices

```
csc2025-attacker@csc2025-attacker:~/Desktop/csc2025-project2$ sudo ./icmp_redirect 163.182.194.25
Available devices
---------------------------------
Index |       IP       |       MAC
---------------------------------
0     | 10.0.2.1       |52:54:00:12:35:00
1     | 10.0.2.2       |52:54:00:12:35:00
2     | 10.0.2.3       |80:00:27:36:DA:66
3     | 10.0.2.16      |80:00:27:6F:58:50
---------------------------------
```

Task II: ICMP redirect attack

- What is ICMP redirect?
  - It is a type of ICMP (Internet Control Message Protocol) message used to inform a host to update its routing information.
    - Purpose: Informs the host of a better route for its traffic.
    - Trigger Condition: Occurs when a router detects unnecessary routing (e.g., packets looping back to the same network segment).
    - Message Content: Contains the IP address of the new next-hop router.
    - Common Use: Optimizes routing by reducing unnecessary hops.

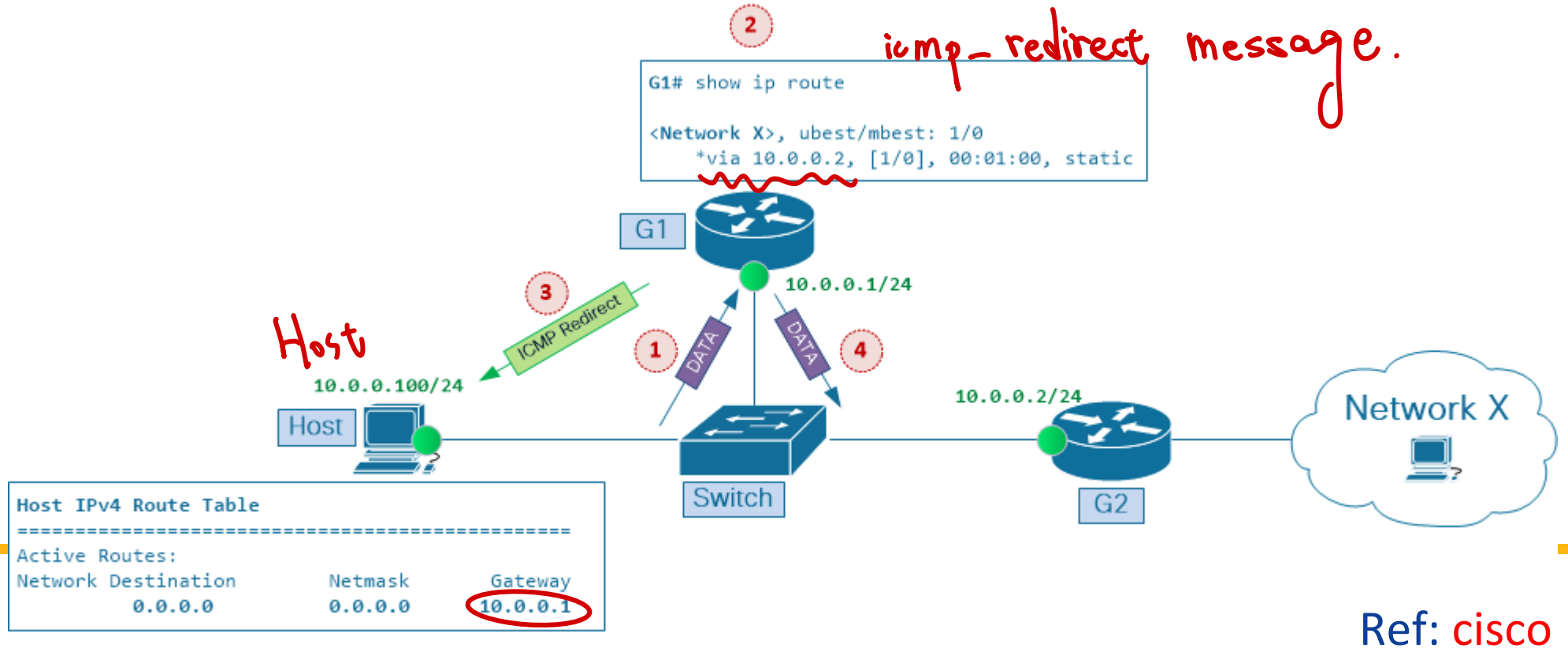
提供在通訊主最主要中的各種問題回饋

ex: ping & traceroute 這兩個網路程式

利用 icmp 協定去執行

Task II: ICMP redirect attack (Cont.)

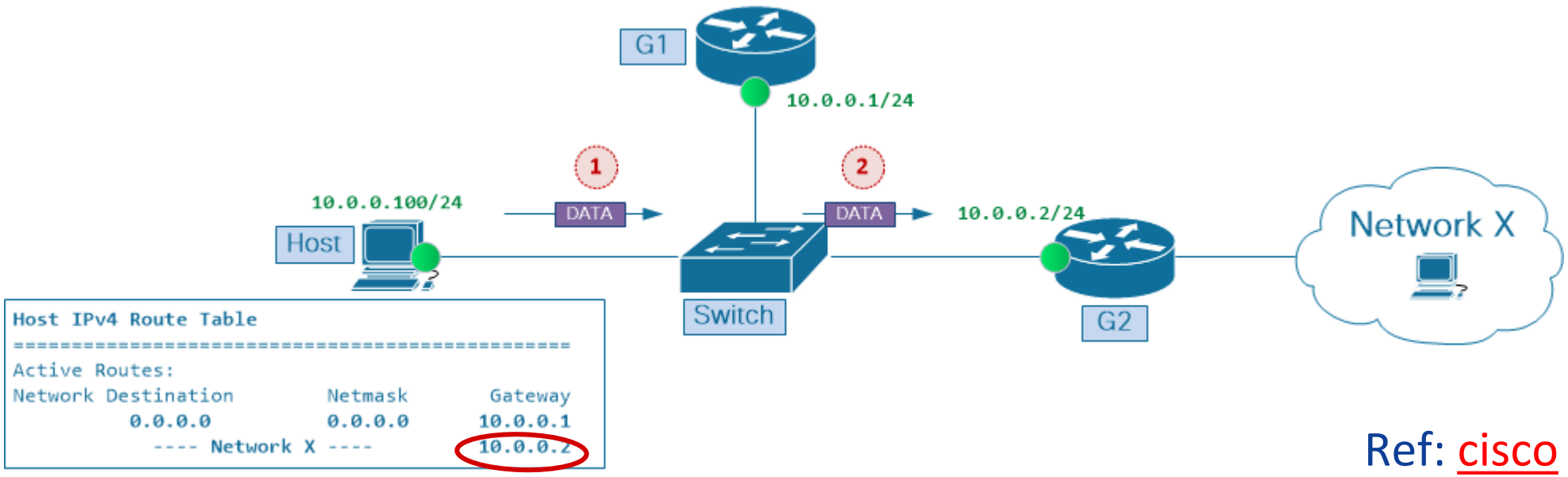
- Router G1 identifies a better route through the G2 and sends an ICMP redirect to the host to update its routing table.



Ref: cisco

Task II: ICMP redirect attack (Cont.)

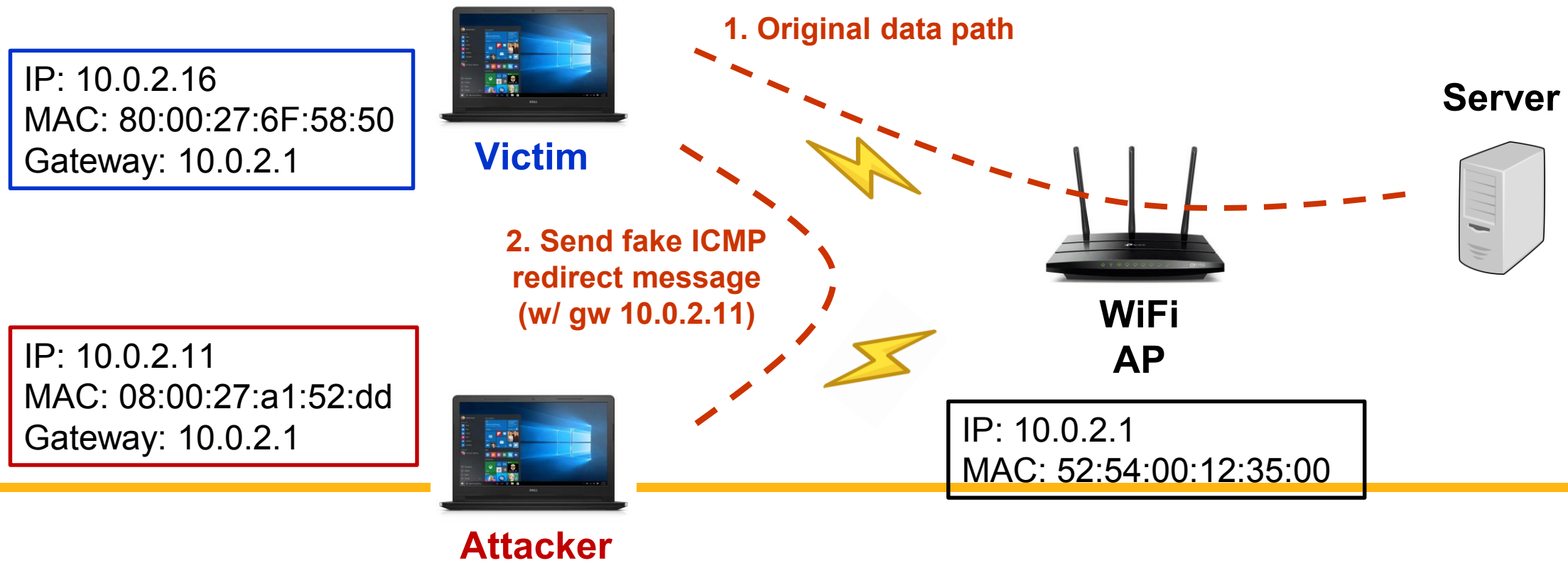
- The host updates its routing table and sets the gateway to G2.



Ref: cisco

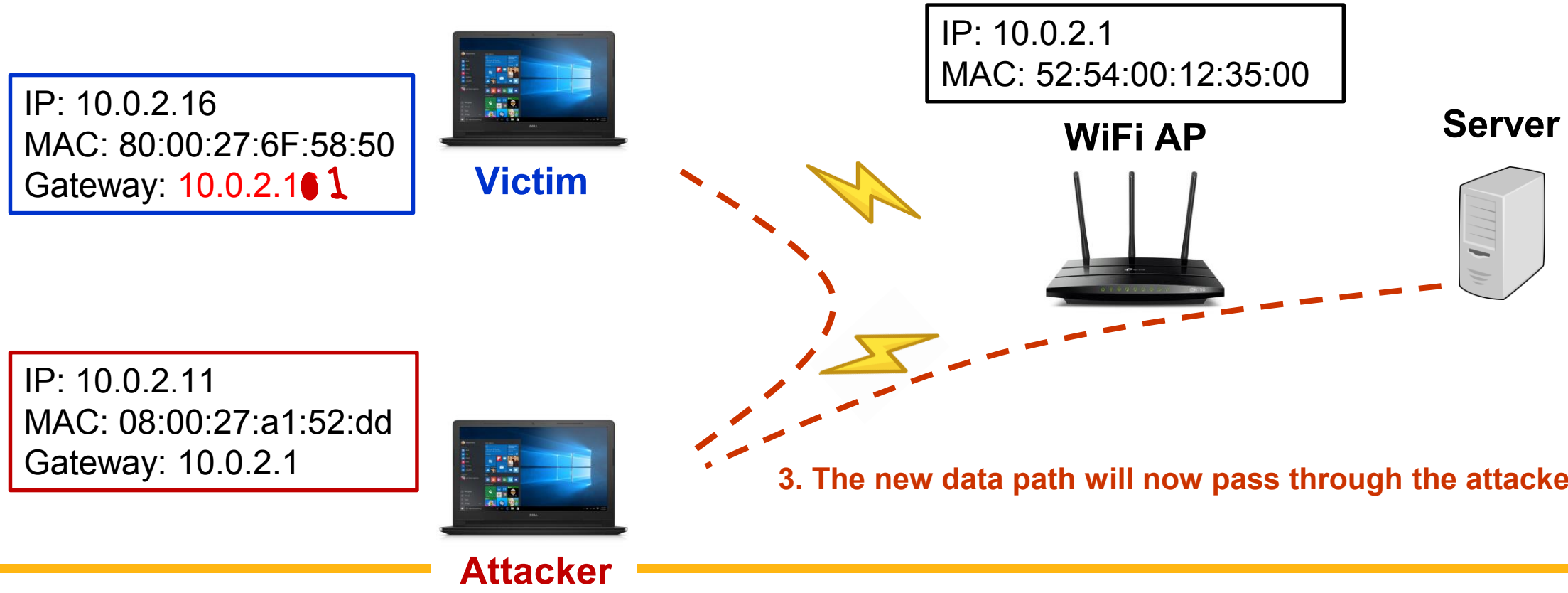
Task II: ICMP redirect attack (Cont.)

- The attacker generates a fake ICMP redirect packet, claiming there is a better route for the victim's traffic.



Task II: ICMP redirect attack (Cont.)

- The victim updates its routing table and sets the gateway as the attacker.



Task II: ICMP redirect attack (Cont.)

- Attacker scans devices and sends fake ICMP redirect message to the victim.

```
csc2025-attacker@csc2025-attacker:~/Desktop/csc2025-project2$ sudo ./icmp_redirect 163.182.194.25
Available devices
---------------------------------
Index |       IP        |       MAC
---------------------------------
0     | 10.0.2.1        |52:54:00:12:35:00
1     | 10.0.2.2        |52:54:00:12:35:00
2     | 10.0.2.3        |80:00:27:36:DA:66
3     | 10.0.2.16       |80:00:27:6F:58:50
---------------------------------
Select Victim IP index: 3
Select Gateway IP index: 0
Victim IP: 10.0.2.16, Gateway IP: 10.0.2.1, Attacker IP: 10.0.2.11
ICMP Redirect packet sent successfully!
```

mac address : 48 bits
6 bytes

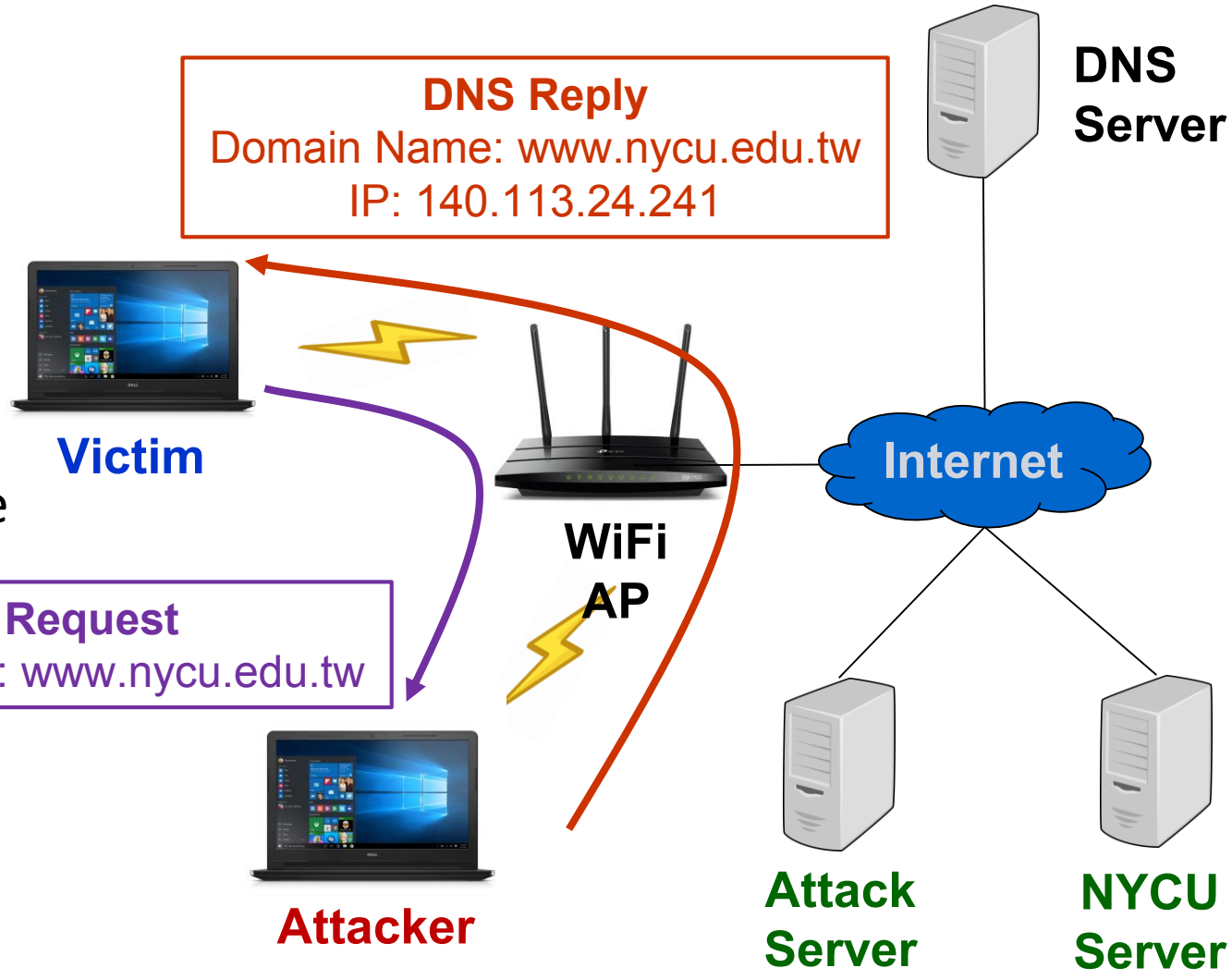
IP address : 32 bits
4 bytes

- The victim updates its routing table and sets the gateway as the attacker.

```
csc2025-victim@csc2025-victim:~$ ip route get 163.182.194.25
163.182.194.25 via 10.0.2.11 dev enp0s3 src 10.0.2.16 uid 1000
    cache <redirected> expires 296sec
```

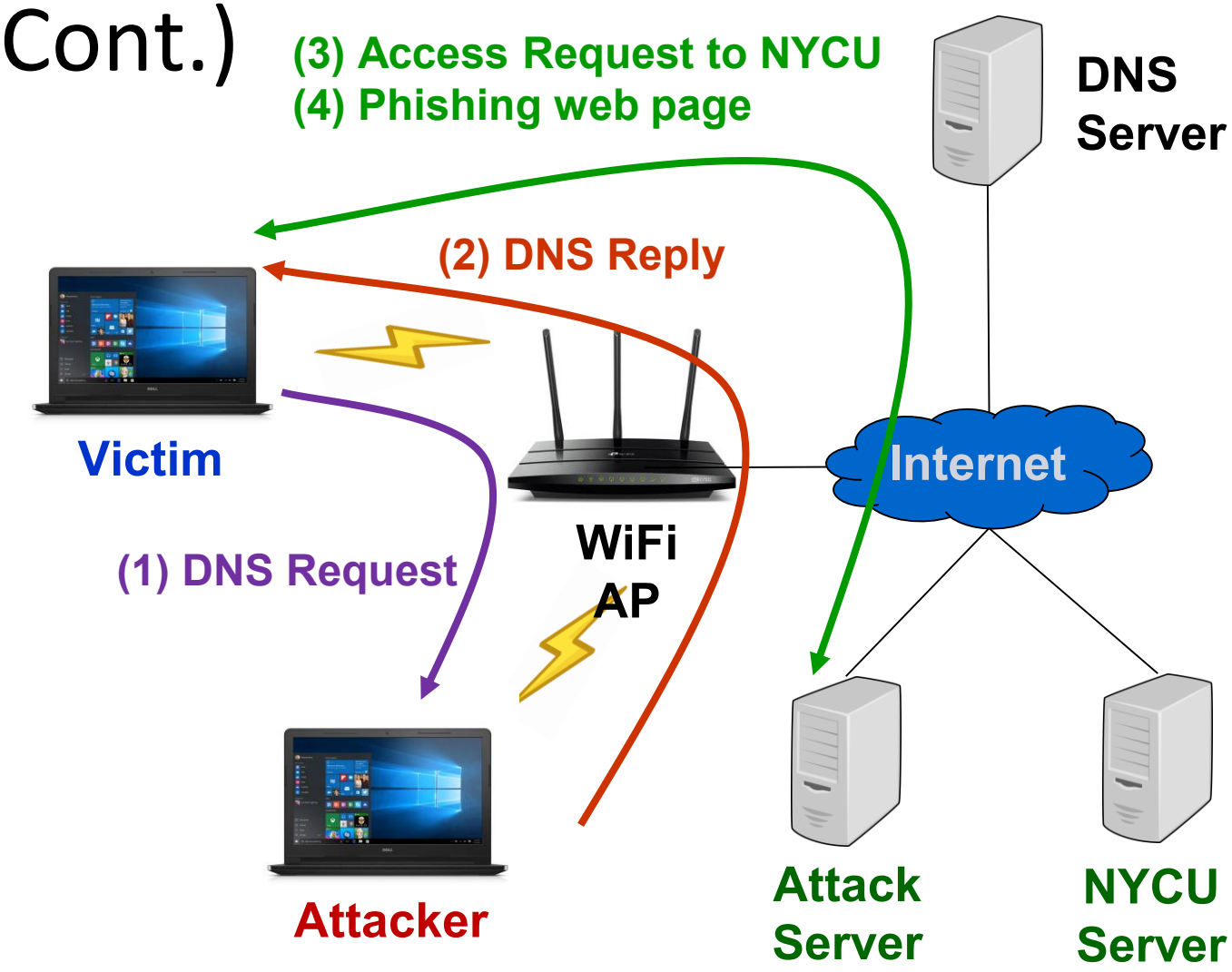
Task III: DNS Spoofing

- Intercept DNS requests for a specific web page and generate spoofed DNS replies with the attack server's IP
  - Hint: DNS format, Netfilter queue
  - Note: You should drop the origin victim DNS request

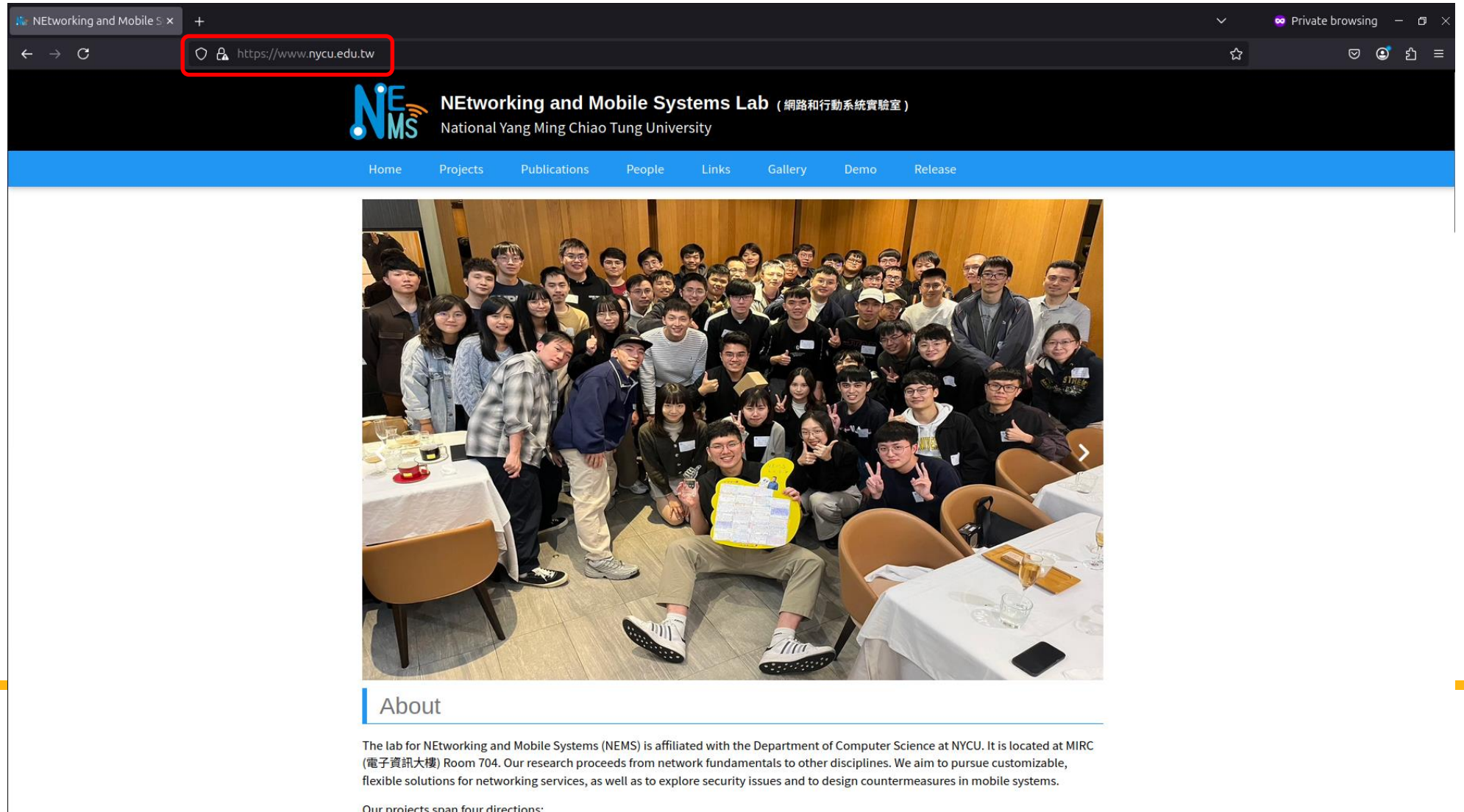


Task III: DNS Spoofing (Cont.)

- Successful attack
  - An access request to NYCU home page will be redirected to the attack server (140.113.24.241)
  - A phishing web page will be shown to Victim



Task III: DNS Spoofing (Cont.)



Requirements

- You need to develop/run your program in a given virtual machine
  - VM image: Please download it from Link
    - Username/password: csc2025/csc2025
  - Network setting: **NAT Network**
- Only C/C++ is allowed for the development
  - To be better familiar with the protocols (Python is not allowed)

Requirements

- Do not hardcode the network interface.
  - During the demo, the program may be run on either VMware or VirtualBox, so ensure that no fixed values are used
- You are allowed to team up. Each team has at most 2 students
  - Teams: discussions are allowed, but no collaboration
- Please only submit your source codes to E3

Important: How to Prepare Your Attack Programs?

- Must provide a **Makefile** which compiles your source codes into two executable files, named **icmp_redirect** and **pharm_attack** (Missing: -20%)

- Test requirements for the programs
  - Must be run in the given VM without any additional tools or libraries
  - Must use the following parameters
    - DNS spoofing for the NYCU home page: http://www.nycu.edu.tw (use private window)
    - Attacker server IP in the DNS spoofing: 140.113.24.241
  - Must work for test commands

Important: How to Prepare Your Attack Programs?

- Results from the ICMP redirect attack
  - Only allowed to run ./icmp_redirect <address> <interface>
  - Print out the IP/MAC addresses of all the Wi-Fi devices/VMs except for Attacker
  - Select the target victim and origin gateway as the struct of fake ICMP redirect packet
  - The victim should update it dynamic routing table (check by “ip route get <address>” on victim)

- Results from the pharming attack
  - Only allowed to run ./pharm_attack (No manual configuration is allowed)
  - Redirect the NYCU home page (www.nycu.edu.tw) to the phishing page (140.113.24.241)

Project Submission

- Due date: 4/16 11:55pm
  - Late submission is not allowed
- Makeup submission (75 points at most): TBA (After the final)
- Submission rules (Wrong file name or format will result in 10 points deduction)
  - Put all your files into a directory and name it using your student ID(s)
    - If your team has two members, please concatenate your IDs separated by “-”
  - Zip the directory and upload the zip file to New E3
  - A sample of the zip file: 01212112-02121221.zip
    - 01212112-02121221
      - Makefile
      - icmp_redirect.cpp
      - pharm_attack.cpp
      - ….

Online Project Demo

- Date: 4/18
- TA will prepare your zip file and run your programs for the demo on behalf of you
- You will
  - be asked to reproduce your ICMP redirect and pharming attacks
  - be only allowed to use “make” to compile all your files, and run your attack binary programs or scripts
  - be not allowed to modify your codes or scripts
  - be asked some questions
  - be responsible to show and explain the outcome to TA

Hint 1: ICMP Redirect Attack

- ICMP redirect format
  - Reference : ICMP Redirect Message Format

Type (8 bits)	Code (8 bits)	Checksum (16 bits)
Gateway Internet Address (32 bits)		
Internet Header + 64 bits of Original Data Datagram (Variable)		

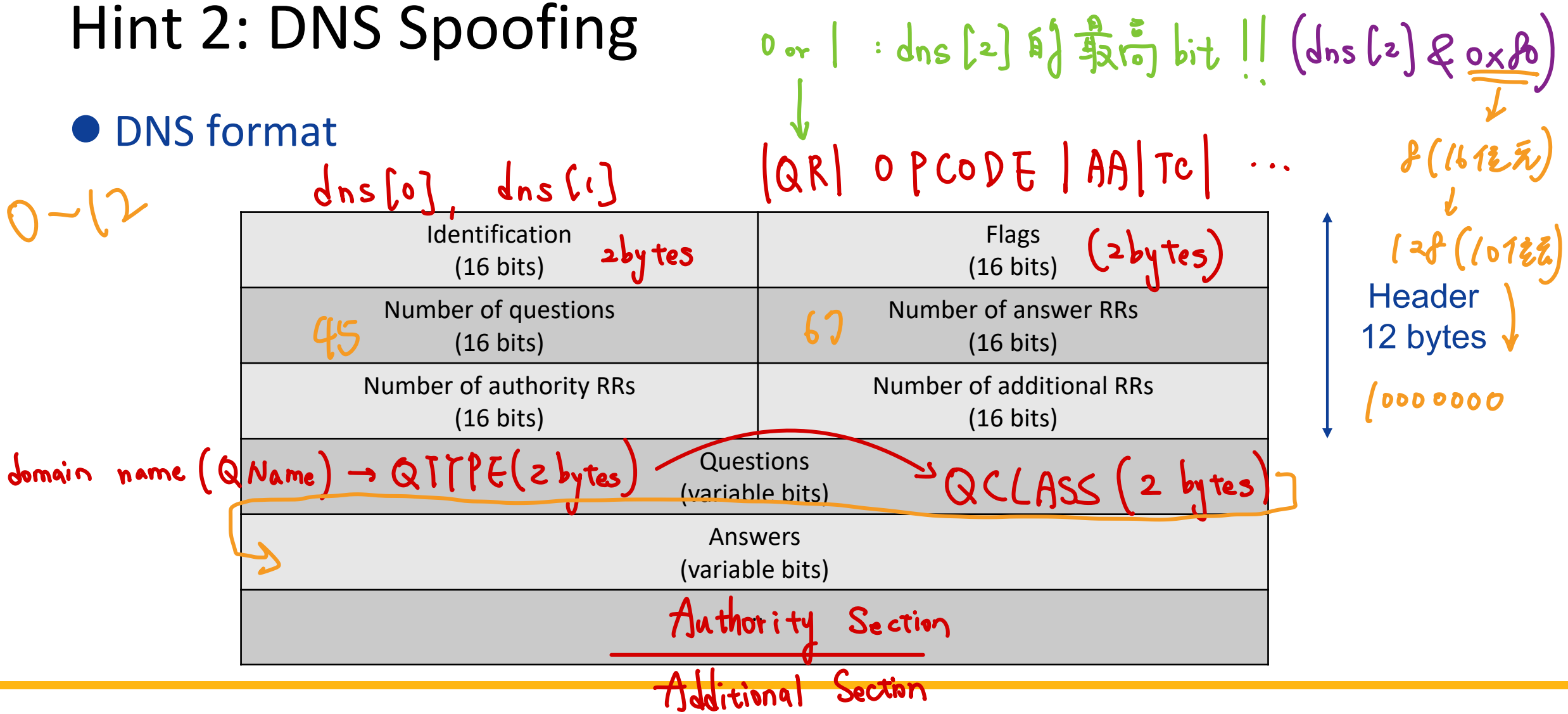
  - You can simply craft Internet Header + 64 bits of Original Data Datagram as an ICMP echo reply packet with a checksum set to 0xffff, and both the Identifier and Sequence Number set to 0.

Hint 1: ICMP Redirect Attack (Cont.)

- To enable the system to accept ICMP redirects, the victim needs to configure the following network settings to 1:
  - net.ipv4.conf.all.accept_redirects
  - net.ipv4.conf.default.accept_redirects
  - net.ipv4.conf.<interface_name>.accept_redirects

Hint 2: DNS Spoofing

- DNS format



Hint 2: DNS Spoofing (Cont.)

- DNS packets may employ message compression
  - Reference: https://datatracker.ietf.org/doc/html/rfc1035#section-4.1.4

Hint 3: Netfilter queue

- Functions:
  - **nfq_open():** open a nfqueue handler.
  - **nfq_close():** close a nfqueue handler.
  - **nfq_unbind_pf():** unbind nfqueue handler from a protocol family.
  - **nfq_bind_pf()**: bind a nfqueue handler to a given protocol family.
  - **nfq_create_queue():**create a new queue handle and return it.
  - **nfq_destroy_queue():** destroy a queue handle.
  - **nfq_set_mode():** set the amount of packet data that nfqueue copies to userspace.
  - **nfq_fd():** get the file descriptor associated with the nfqueue handler.
  - **nfq_handle_packet():** handle a packet received from the nfqueue subsystem.
  - **nfq_get_msg_packet_hdr():** return the metaheader that wraps the packet.
  - **nfq_get_payload():** get payload.
  - **nfq_set_verdict():** issue a verdict on a packet.
- Reference: https://netfilter.org/projects/libnetfilter_queue/doxygen/html/index.html

Hint 3: Netfilter queue(Cont.)

- nfq_set_verdict(struct nfq_q_handle *qh, uint32_t id, uint32_t verdict, uint32_t data_len, const unsigned char *buf):
  - **Only read the packet:** data_len=0, *buf = nullptr
  - **Modify packet:** data_len=new packet length, *buf = Head of buffer that stored new packet data

Reference 1: ICMP Redirect Attack

- This paper provides guidance on how to probe the victim in order to construct an accurate Internet Header along with the first 64 bits of the Original Data Datagram.
  - "Man-in-the-Middle Attacks without Rogue AP: When WPAs Meet ICMP Redirects," 2023 IEEE S&P, San Francisco, CA, USA, 2023

- In this project, we don’t need to do it.

Questions?