Introduction to Computer Security

Project 1: DNS Reflection and Amplification Attacks

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Goals

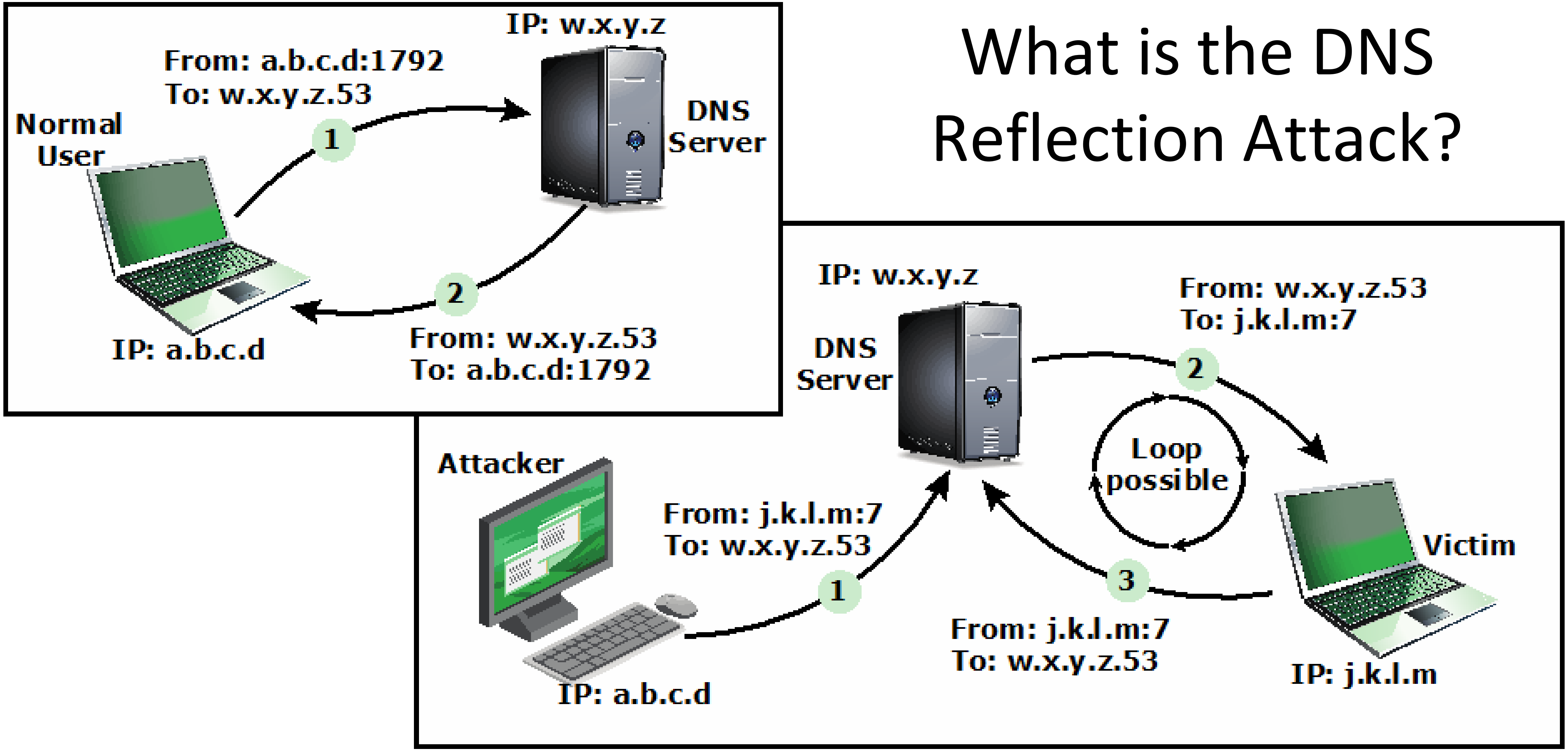
- Understand how to launch DNS reflection and amplification attacks and then defend against them

- You will learn how to
  - Program with raw sockets
  - Generate IP packets with spoofed IP addresses
  - Trace packets using Wireshark
  - Fabricate DNS query messages
  - Launch DNS reflection and amplification attacks

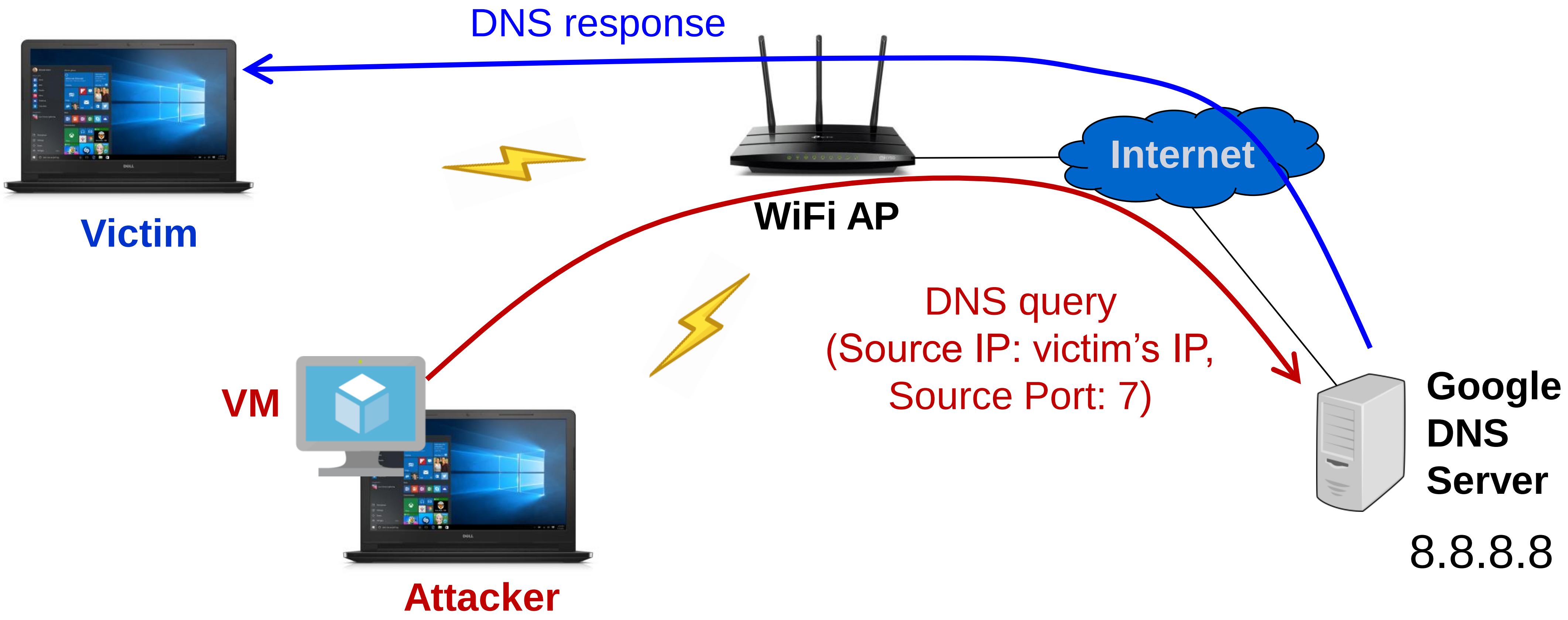
Requirements

- You need to develop/run your program in a given virtual machine
  - VMware Workstation Player: Please download it from VMware
  - VM image: Please download it from Link
    - Username/password: cs2019/cs2019
- The language you use must be C/C++
- You are allowed to team up. Each team has at most 2 students
  - Teams: discussions are allowed, but no collaboration
- Please submit your source codes and then use them to show your demo
- TA: Yu-Yen Huang (hyyisgood@gmail.com)

What is the DNS Reflection Attack?



Your DNS Reflection Attack



Two Tasks

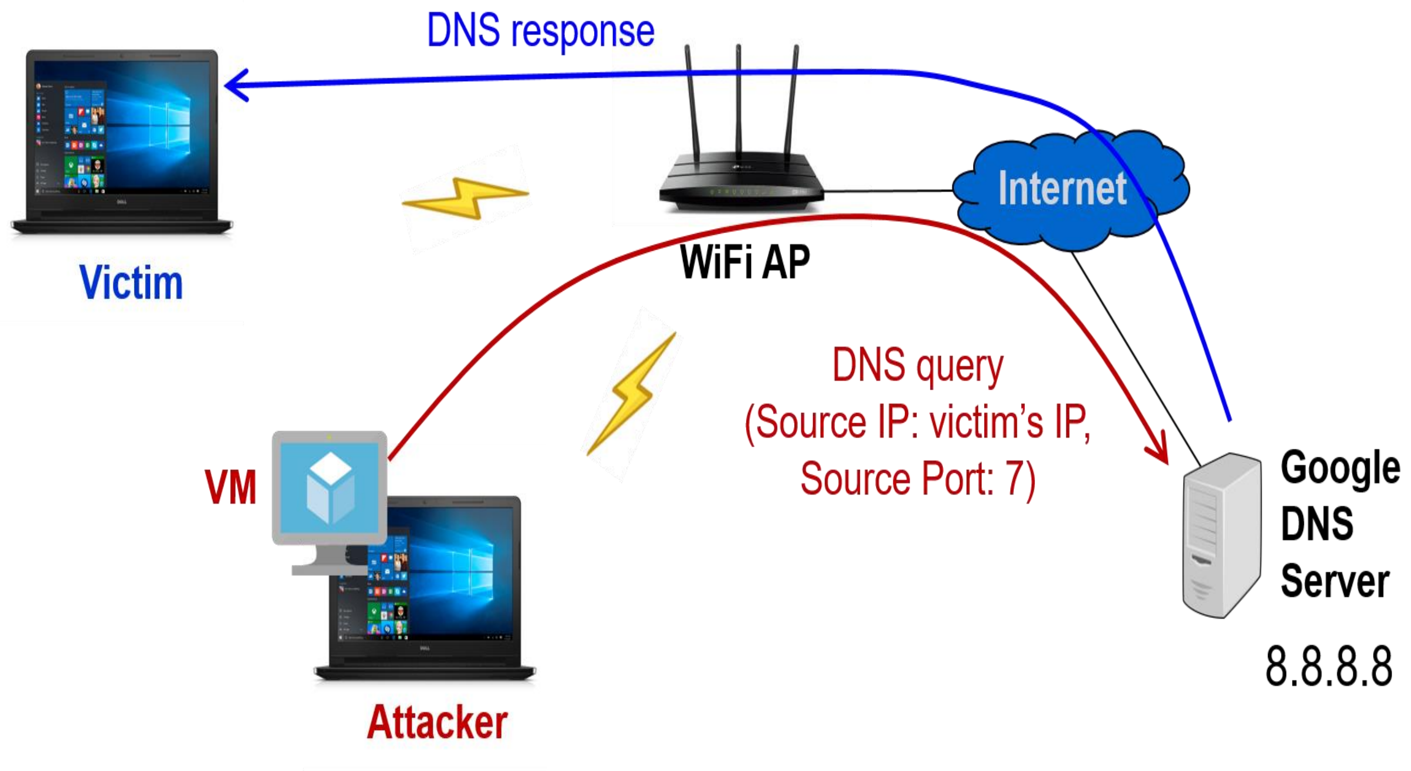
- Task I: DNS reflection attack (50%)
- Task II: DNS amplification attack (35%)
  - Amplification ratio: $R = S_r / S_q$
    - S_q:packet size of the DNS query
    - S_r:packet size of the DNS response
  - $3 \leq R < 6$: **20%**, $6 \leq R < 10$: **25%**, $10 \leq R$: **35%**
- Demo Q&A (15%)

Task I: DNS Reflection Attack

(Given a DNS server's IP and the victim's IP)

- (Attacker) Fabricates a DNS query message with a UDP packet

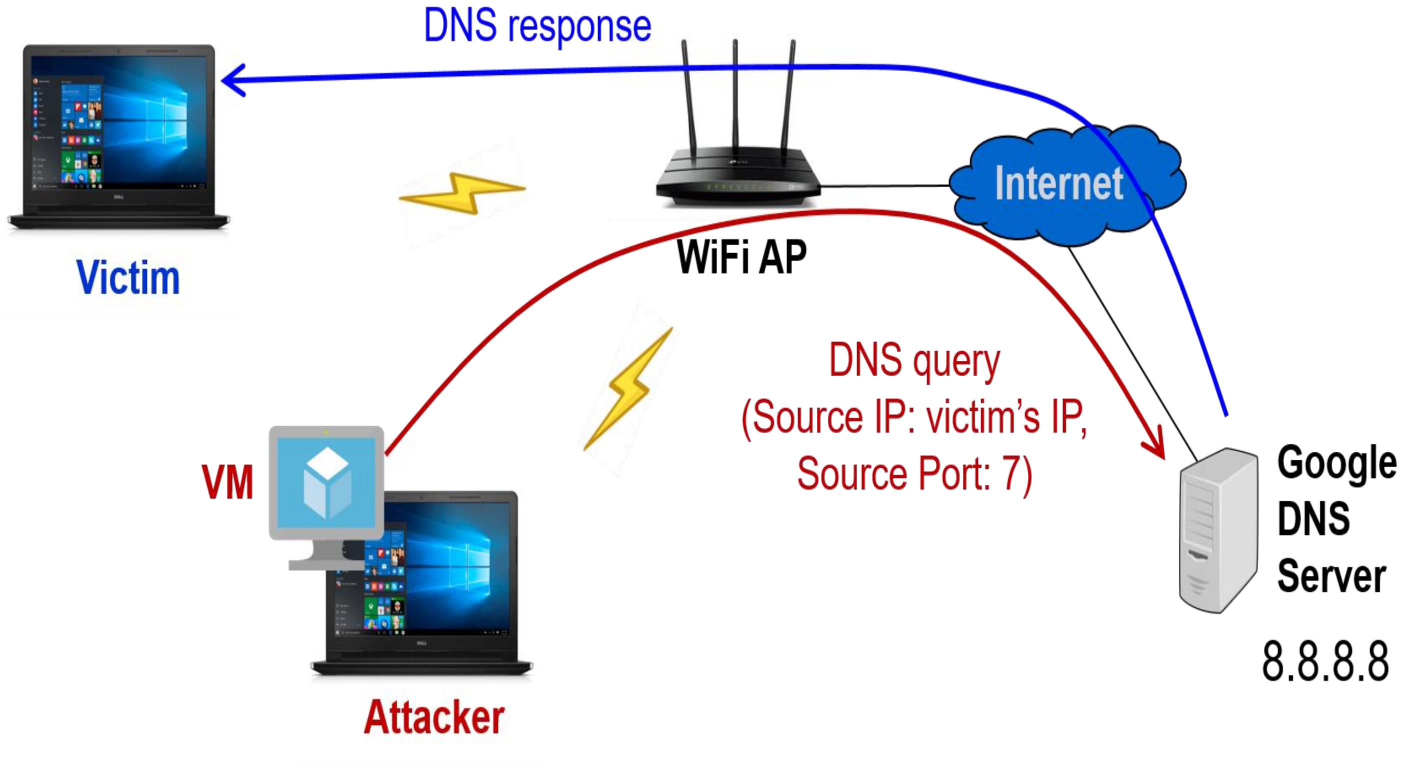
- (Victim) Uses Wireshark to check whether the victim receives the DNS response



Task II: DNS Amplification Attack

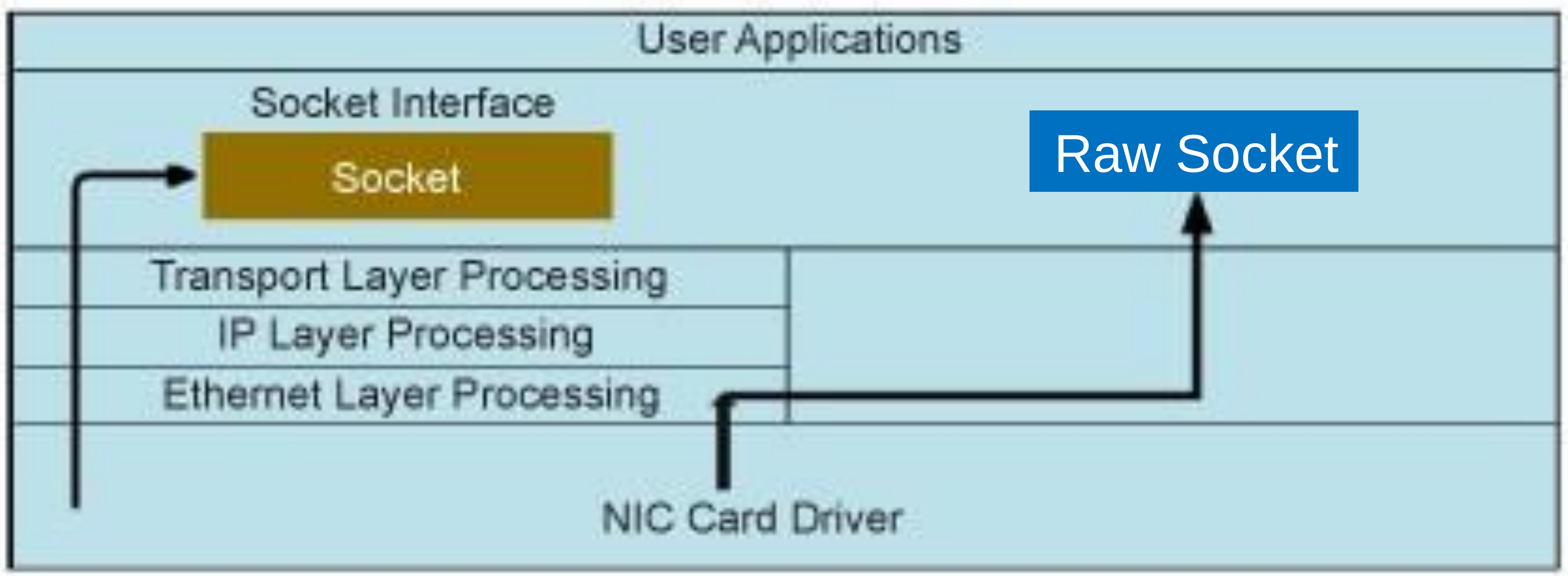
(Given a DNS server's IP and the victim's IP)

- (Attacker) Fabricates a DNS query message with a UDP packet
  - □ Checks its packet size using Wireshark
- (Victim) Uses Wireshark to check the packet size of the DNS response
  - □ Obtains the amplification ratio



Hint I: How to Create IP Spoofing Packets?

- Using Raw Socket
  - Normal network sockets vs. Raw sockets



Source of figures: A Guide to Using Raw Sockets by Subodh Saxena

Hint I: How to Create IP Spoofing Packets? (Cont.)

- Implementation using Raw sockets
  - □ Create a raw socket with UDP protocol

    ```
    sd = socket(PF_INET, SOCK_RAW, IPPROTO_UDP)
    ```

  - □ Fabricate the IP header

    ```
    struct ipheader *ip = (struct ipheader *) buffer;
    ip->iph_ihl = 5;
    ….
    ip->iph_souceip = inet_addr(arhv[1]);
    ….
    ```

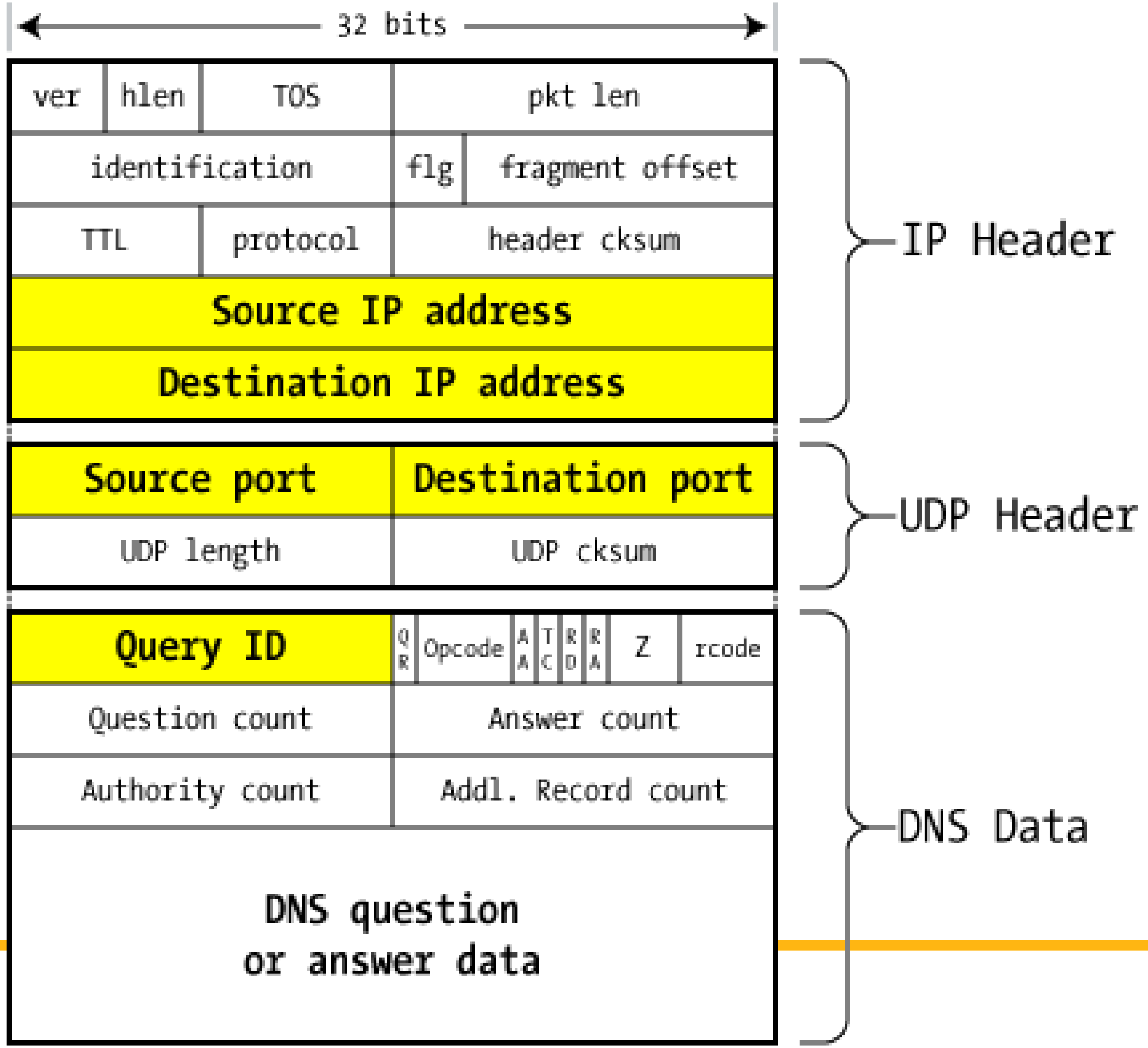
  - □ Fabricate the UDP header

    ```
    struct udpheader *udp = …
    udp->udph_srcport = htons(atoi(argv[2]));
    ….
    ```

  - □ Calculate the checksum over IP and UDP headers
  - □ Create DNS query in the UDP payload
- Reference: Tutorial Sample code

Hint I: How to Create IP Spoofing Packets? (Cont.)

- DNS/UDP/IP packet format



32 bits

ver | hlen | TOS | pkt len

identification | flg | fragment offset

TTL | protocol | header cksum

Source IP address

Destination IP address

Source port | Destination port

UDP length | UDP cksum

Query ID | QR | Opcode | AA | TC | RD | RA | Z | rcode

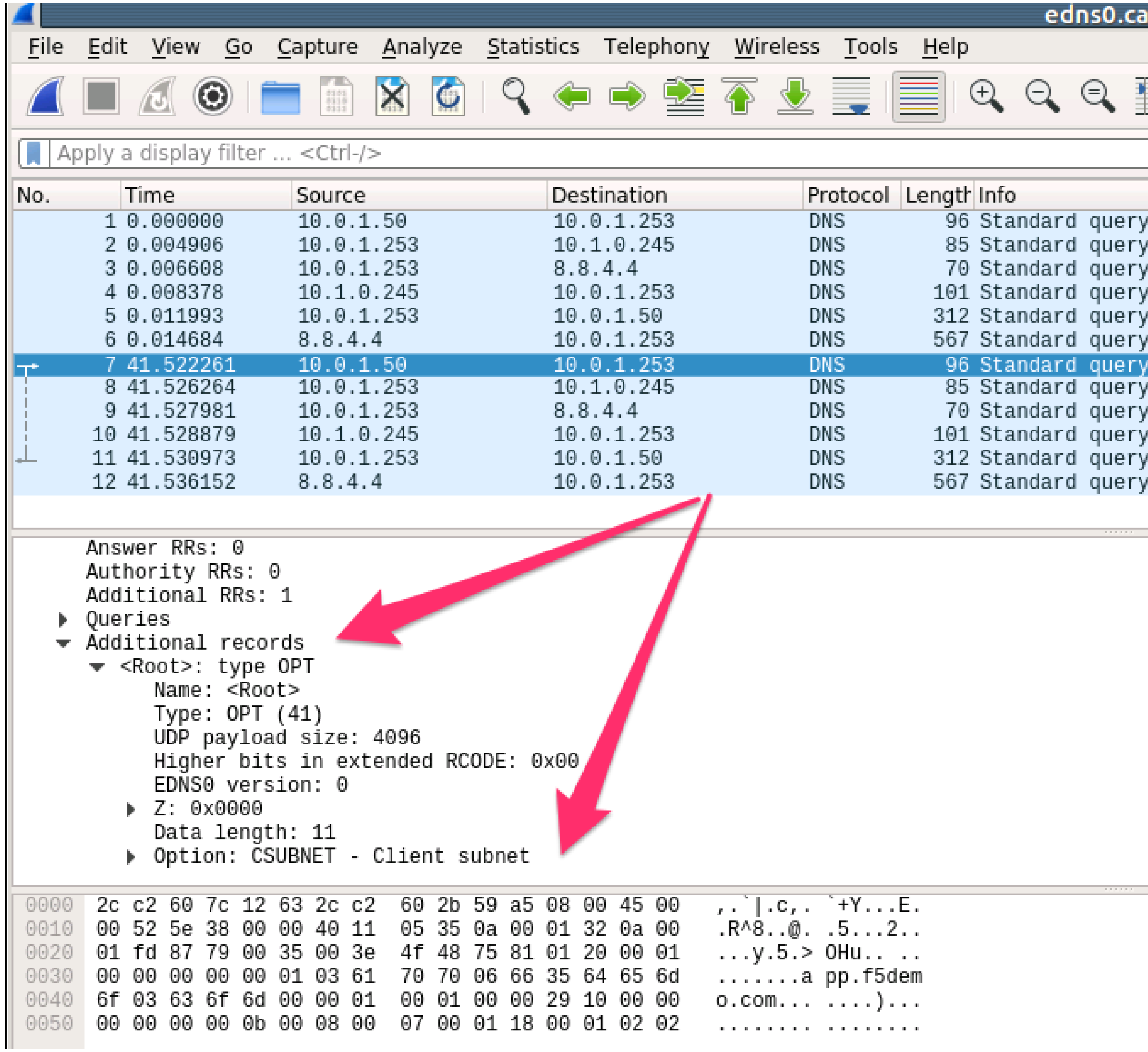
Question count | Answer count

Authority count | Addl. Record count

DNS question
or answer data

Hint 2: How to Create DNS Query Message?

- Generate a DNS query (e.g., using ping) and then capture it using Wireshark
- Fill in the content based on the observation from Wireshark


edns0.ca
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter … <Ctrl-/>

```
No.   Time        Source        Destination   Protocol Length Info
    1 0.000000    10.0.1.50     10.0.1.253    DNS          96 Standard query
    2 0.004906    10.0.1.253    10.1.0.245    DNS          85 Standard query
    3 0.006608    10.0.1.253    8.8.4.4       DNS          70 Standard query
    4 0.008378    10.1.0.245    10.0.1.253    DNS         101 Standard query
    5 0.011993    10.0.1.253    10.0.1.50     DNS         312 Standard query
    6 0.014684    8.8.4.4       10.0.1.253    DNS         567 Standard query
    7 41.522261   10.0.1.50     10.0.1.253    DNS          96 Standard query
    8 41.526264   10.0.1.253    10.1.0.245    DNS          85 Standard query
    9 41.527981   10.0.1.253    8.8.4.4       DNS          70 Standard query
   10 41.528879   10.1.0.245    10.0.1.253    DNS         101 Standard query
   11 41.530973   10.0.1.253    10.0.1.50     DNS         312 Standard query
   12 41.536152   8.8.4.4       10.0.1.253    DNS         567 Standard query
```

```
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 1
  ▸ Queries
  ▾ Additional records
    ▾ <Root>: type OPT
        Name: <Root>
        Type: OPT (41)
        UDP payload size: 4096
        Higher bits in extended RCODE: 0x00
        EDNS0 version: 0
      ▸ Z: 0x0000
        Data length: 11
      ▸ Option: CSUBNET - Client subnet
```

```
0000  2c c2 60 7c 12 63 2c c2  60 2b 59 a5 08 00 45 00   ,.`|.c,. `+Y...E.
0010  00 52 5e 38 00 00 40 11  05 35 0a 00 01 32 0a 00   .R^8..@. .5...2..
0020  01 fd 87 79 00 35 00 3e  4f 48 75 81 01 20 00 01   ...y.5.> OHu.. ..
0030  00 00 00 00 00 01 03 61  70 70 06 66 35 64 65 6d   .......a pp.f5dem
0040  6f 03 63 6f 6d 00 00 01  00 01 00 00 29 10 00 00   o.com... ....)...
0050  00 00 00 00 0b 00 08 00  07 00 01 18 00 01 02 02   ........ ........
```

Project Submission

- Due date: 3/27 11:55pm
- Submission rules
  - Put all your files into a directory, the name of which is your student ID, and upload its zip file to New e3
    - Don’t include executable files
  - If your team has two members, please create a blank file with the name as the concatenation of your IDs separated by “-”
  - Sample: 0878778.zip
    - 0878778-0889008
    - Makefile
    - dns_attack.cpp
    - ….

Demo

- Date: 3/28 (9:30am-5pm) @ EC315
- TA will prepare your zip file for you to demo
- You will
  - □ be asked to launch the amplification attack from one PC, and verify whether it succeeds and its ratio using Wireshark at another PC
  - □ be only allowed to "make" and input required commands
    - A Makefile is needed to compile your source files
  - □ be not allowed to modify your codes
  - □ be asked some questions (15%)
    - e.g., how do you do DNS amplification attack (explaination with your codes)? How to defend against this attack?
  - □ be responsible to show the traces to TA and explain why you have successfully launched attacks and the amplification ratio

Questions?