Course	COMP 7003
Program	Bachelor of Science in Applied Computer Science
Term	January 2024

- This is an individual programming assignment.

Objective

- Develop the ability to capture and analyze network traffic at the packet level using Scapy in Python.
- Understand packet structures by converting raw data to a hex dump, parsing the fields of various network layers, and displaying the results in a clear and organized format.

Learning Outcomes

- Technical Skill in Packet Analysis: Gain proficiency in capturing, filtering, and analyzing network packets using Scapy and Python.
- Understanding Network Protocols: Strengthen knowledge of Ethernet, IPv4, ICMP, TCP, and UDP protocols by dissecting packet fields and identifying key components.
- Data Handling and Parsing: Improve the ability to convert raw packet data into a human-readable form (e.g., hex dumps) and extract relevant header information.
- Software Development Practice: Enhance coding skills and experience implementing structured, maintainable Python solutions that meet specified requirements.
- Problem-Solving and Debugging: Develop the capacity to troubleshoot, refine, and test code to ensure accurate packet capture and analysis.

Assignment Details

- You will receive a starter code template that uses Scapy to capture network traffic.
- Your task is to:
  - Capture packets on a specified interface.
  - Filter and identify packets using the required protocols: Ethernet, IPv4, ICMP, TCP, and UDP.
  - Convert each captured packet into a hex dump.
  - Parse the packet from the hex dump and display its fields in a format matching the provided reference screenshots.
  - Test your program with multiple packets for each protocol type, ensuring it accurately identifies and displays their details.
  - Screenshots of the expected output are at the end of this document.

  - The starting source code is provided.

Requirements

- Protocols: Must support Ethernet, IPv4, ICMP, TCP, UDP, and DNS.
- Hex Dump: Implement functionality to produce a hex dump of each packet's raw data.
- Field Extraction: Accurately parse and display relevant fields (e.g., source/destination MAC and IP addresses, protocol fields, source/destination ports for TCP/UDP details).
- Output Format: Match the style and clarity of the provided screenshots. Maintain consistent and organized formatting.
- Code Quality: Write clean, commented code that follows best practices in Python programming.
- Testing: Collect and analyze multiple packets from each supported protocol to verify that your program works correctly.

Constraints

- Ensure your code runs on the lab environment's standard Python installation with Scapy pre-installed.

Resources

- Official Scapy documentation
- Course materials and lecture notes on packet structure and protocols
- Provided starter code and reference screenshots

Submission

- Ensure your submission meets all the guidelines, including formatting, file type, and submission.
- Follow the AI usage guidelines.
- Be aware of the late submission policy to avoid losing marks.
- ***Note: Please strictly adhere to the submission requirements to ensure you don't lose any marks.***

Evaluation

Topic	Value
Correct Output	50%
Design	25%

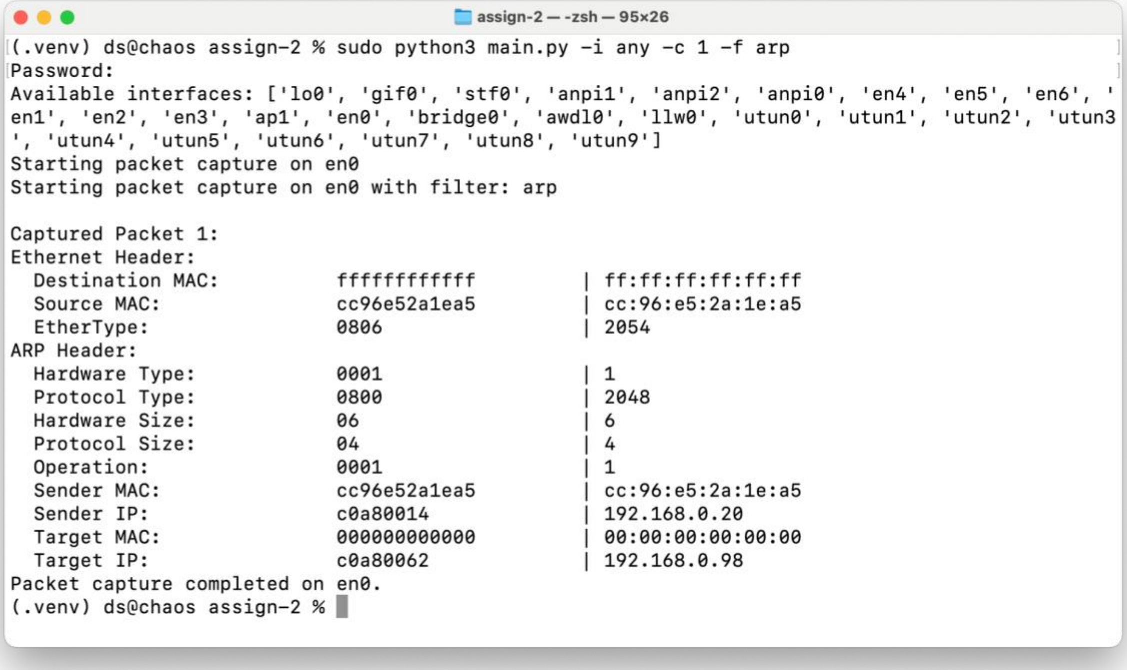
Testing	25%
Total	100%

Hints

- Review Scapy’s layer structure and methods for filtering and dissecting packets. Understanding show() and layer fields will help determine which fields to print.
- Use the provided starter code as a template. Focus on integrating your parsing logic into the given structure.
- Experiment with capturing traffic from different sources (pinging hosts, making DNS queries, etc.) to generate test packets.
- Start testing and debugging early. Make incremental changes and confirm that each protocol layer parses correctly before moving on.
- To capture and generate traffic:

Protocol	Filter	Capture Command	Traffic Generation Command
`ARP`	`arp`	`sudo python3 main.py -i any -c 1 -f arp`	`arping -c 1 <IP_ADDRESS>`
`UDP`	`udp`	`sudo python3 main.py -i any -c 1 -f udp`	`echo "Hello, World!" | ncat --udp 192.168.0.1 12345`
`TCP`	`tcp`	`sudo python3 main.py -i any -c 1 -f tcp`	`curl http://<IP_ADDRESS> or telnet <IP_ADDRESS> <PORT>`
`ICMP`	`icmp`	`sudo python3 main.py -i any -c 1 -f icmp`	`ping -c 1 <IP_ADDRESS>`

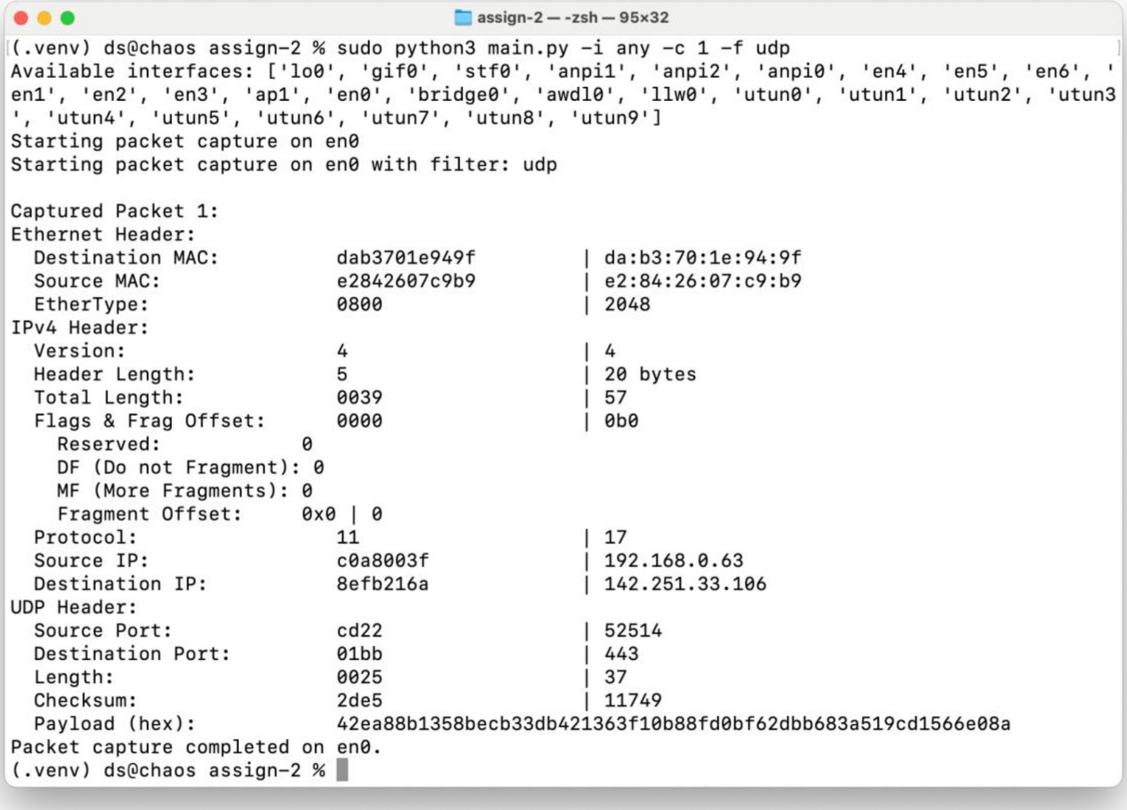
ARP



```
(.venv) ds@chaos assign-2 % sudo python3 main.py -i any -c 1 -f arp
Password:
Available interfaces: ['lo0', 'gif0', 'stf0', 'anpi1', 'anpi2', 'anpi0', 'en4', 'en5', 'en6', '
en1', 'en2', 'en3', 'ap1', 'en0', 'bridge0', 'awdl0', 'llw0', 'utun0', 'utun1', 'utun2', 'utun3
', 'utun4', 'utun5', 'utun6', 'utun7', 'utun8', 'utun9']
Starting packet capture on en0
Starting packet capture on en0 with filter: arp

Captured Packet 1:
Ethernet Header:
  Destination MAC:          ffffffffffff         | ff:ff:ff:ff:ff:ff
  Source MAC:               cc96e52a1ea5         | cc:96:e5:2a:1e:a5
  EtherType:                0806                 | 2054
ARP Header:
  Hardware Type:            0001                 | 1
  Protocol Type:            0800                 | 2048
  Hardware Size:            06                   | 6
  Protocol Size:            04                   | 4
  Operation:                0001                 | 1
  Sender MAC:               cc96e52a1ea5         | cc:96:e5:2a:1e:a5
  Sender IP:                c0a80014             | 192.168.0.20
  Target MAC:               000000000000         | 00:00:00:00:00:00
  Target IP:                c0a80062             | 192.168.0.98
Packet capture completed on en0.
(.venv) ds@chaos assign-2 % 
```

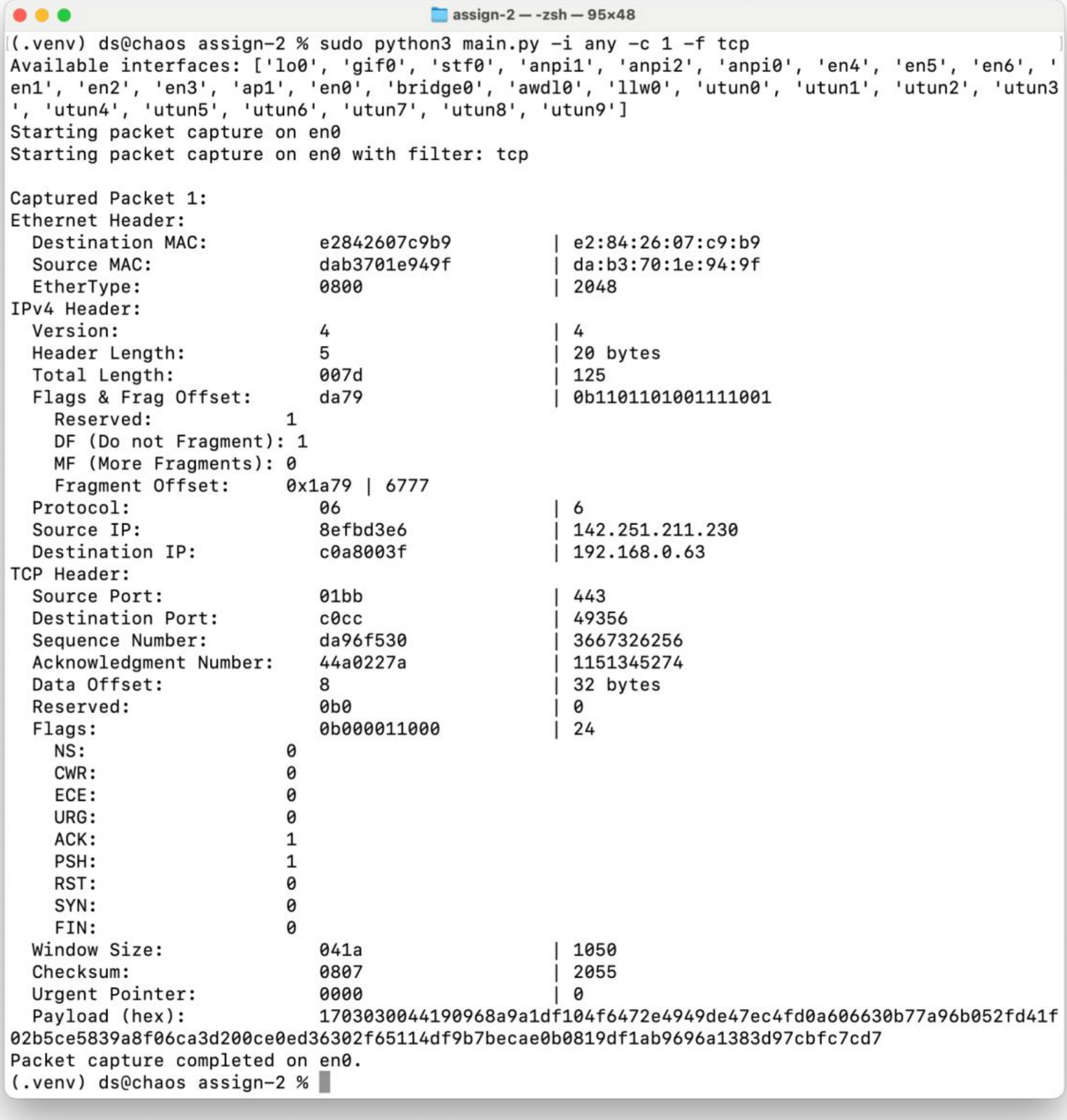
UDP



```
(.venv) ds@chaos assign-2 % sudo python3 main.py -i any -c 1 -f udp
Available interfaces: ['lo0', 'gif0', 'stf0', 'anpi1', 'anpi2', 'anpi0', 'en4', 'en5', 'en6', '
en1', 'en2', 'en3', 'ap1', 'en0', 'bridge0', 'awdl0', 'llw0', 'utun0', 'utun1', 'utun2', 'utun3
', 'utun4', 'utun5', 'utun6', 'utun7', 'utun8', 'utun9']
Starting packet capture on en0
Starting packet capture on en0 with filter: udp

Captured Packet 1:
Ethernet Header:
  Destination MAC:          dab3701e949f         | da:b3:70:1e:94:9f
  Source MAC:               e2842607c9b9         | e2:84:26:07:c9:b9
  EtherType:                0800                 | 2048
IPv4 Header:
  Version:                  4                    | 4
  Header Length:            5                    | 20 bytes
  Total Length:             0039                 | 57
  Flags & Frag Offset:      0000                 | 0b0
    Reserved:            0
    DF (Do not Fragment): 0
    MF (More Fragments): 0
    Fragment Offset:     0x0 | 0
  Protocol:                 11                   | 17
  Source IP:                c0a8003f             | 192.168.0.63
  Destination IP:           8efb216a             | 142.251.33.106
UDP Header:
  Source Port:              cd22                 | 52514
  Destination Port:         01bb                 | 443
  Length:                   0025                 | 37
  Checksum:                 2de5                 | 11749
  Payload (hex):            42ea88b1358becb33db421363f10b88fd0bf62dbb683a519cd1566e08a
Packet capture completed on en0.
(.venv) ds@chaos assign-2 % 
```

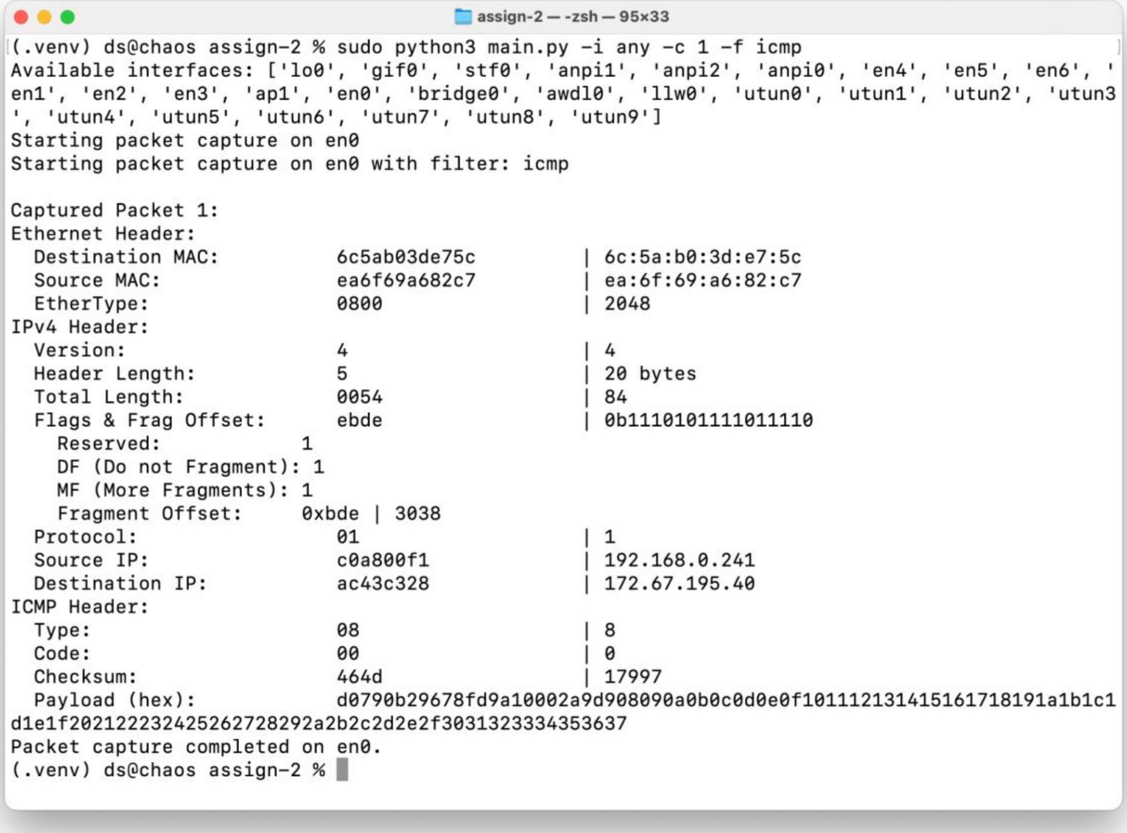
TCP



```
(.venv) ds@chaos assign-2 % sudo python3 main.py -i any -c 1 -f tcp
Available interfaces: ['lo0', 'gif0', 'stf0', 'anpi1', 'anpi2', 'anpi0', 'en4', 'en5', 'en6', '
en1', 'en2', 'en3', 'ap1', 'en0', 'bridge0', 'awdl0', 'llw0', 'utun0', 'utun1', 'utun2', 'utun3
', 'utun4', 'utun5', 'utun6', 'utun7', 'utun8', 'utun9']
Starting packet capture on en0
Starting packet capture on en0 with filter: tcp

Captured Packet 1:
Ethernet Header:
  Destination MAC:            e2842607c9b9           | e2:84:26:07:c9:b9
  Source MAC:                 dab3701e949f           | da:b3:70:1e:94:9f
  EtherType:                  0800                   | 2048
IPv4 Header:
  Version:                    4                      | 4
  Header Length:              5                      | 20 bytes
  Total Length:               007d                   | 125
  Flags & Frag Offset:        da79                   | 0b1101101001111001
    Reserved:              1
    DF (Do not Fragment): 1
    MF (More Fragments): 0
    Fragment Offset:       0x1a79 | 6777
  Protocol:                   06                     | 6
  Source IP:                  8efbd3e6               | 142.251.211.230
  Destination IP:             c0a8003f               | 192.168.0.63
TCP Header:
  Source Port:                01bb                   | 443
  Destination Port:           c0cc                   | 49356
  Sequence Number:            da96f530               | 3667326256
  Acknowledgment Number:      44a0227a               | 1151345274
  Data Offset:                8                      | 32 bytes
  Reserved:                   0b0                    | 0
  Flags:                      0b000011000            | 24
    NS:                    0
    CWR:                   0
    ECE:                   0
    URG:                   0
    ACK:                   1
    PSH:                   1
    RST:                   0
    SYN:                   0
    FIN:                   0
  Window Size:                041a                   | 1050
  Checksum:                   0807                   | 2055
  Urgent Pointer:             0000                   | 0
  Payload (hex):              1703030044190968a9a1df104f6472e4949de47ec4fd0a606630b77a96b052fd41f
02b5ce5839a8f06ca3d200ce0ed36302f65114df9b7becae0b0819df1ab9696a1383d97cbfc7cd7
Packet capture completed on en0.
(.venv) ds@chaos assign-2 % 
```

ICMP



```
(.venv) ds@chaos assign-2 % sudo python3 main.py -i any -c 1 -f icmp
Available interfaces: ['lo0', 'gif0', 'stf0', 'anpi1', 'anpi2', 'anpi0', 'en4', 'en5', 'en6', '
en1', 'en2', 'en3', 'ap1', 'en0', 'bridge0', 'awdl0', 'llw0', 'utun0', 'utun1', 'utun2', 'utun3
', 'utun4', 'utun5', 'utun6', 'utun7', 'utun8', 'utun9']
Starting packet capture on en0
Starting packet capture on en0 with filter: icmp

Captured Packet 1:
Ethernet Header:
  Destination MAC:           6c5ab03de75c           | 6c:5a:b0:3d:e7:5c
  Source MAC:                ea6f69a682c7           | ea:6f:69:a6:82:c7
  EtherType:                 0800                   | 2048
IPv4 Header:
  Version:                   4                      | 4
  Header Length:             5                      | 20 bytes
  Total Length:              0054                   | 84
  Flags & Frag Offset:       ebde                   | 0b1110101111011110
    Reserved:             1
    DF (Do not Fragment): 1
    MF (More Fragments): 1
    Fragment Offset:      0xbde | 3038
  Protocol:                  01                     | 1
  Source IP:                 c0a800f1               | 192.168.0.241
  Destination IP:            ac43c328               | 172.67.195.40
ICMP Header:
  Type:                      08                     | 8
  Code:                      00                     | 0
  Checksum:                  464d                   | 17997
  Payload (hex):             d0790b29678fd9a10002a9d908090a0b0c0d0e0f101112131415161718191a1b1c1
d1e1f202122232425262728292a2b2c2d2e2f3031323334353637
Packet capture completed on en0.
(.venv) ds@chaos assign-2 %
```