ICSI 516 Project One – Reliable File Transfer (Part Two: UDP Stop-and-Wait)

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Part Two: UDP Client-Server File Transfer (Stop-and-Wait)

Overview

In this part, the same file transfer system was reimplemented using **UDP** instead of TCP. Unlike TCP, UDP provides no reliability or ordering guarantees; hence, a custom **Stop-and-Wait ARQ** mechanism was added to ensure that each data chunk is acknowledged before sending the next one.

The program supports three commands identical to Part One:

- put <file> upload a file from client to server.
- get <file> download a file from server to client.
- quit terminate the connection.

Both put and get use a sender–receiver interaction pattern in which:

- 1. Sender transmits a LEN: bytes control packet.
- 2. Sender transmits data chunks of 1000 bytes each (DATA:#|payload).
- 3. Receiver replies with ACK:# for each chunk.
- 4. Once all data is received, the receiver sends a FIN to terminate the session.

Timeouts of 1 second were implemented for the following:

- LEN timeout: if data doesn't arrive soon after LEN.
- ACK timeout: if ACK isn't received after sending a packet.
- DATA timeout: if new data isn't received after sending ACK.

Command-Line Usage

python3 clientUDP.py 127.0.0.1 9090

```
Server: python3 serverUDP.py <port>
Client: python3 clientUDP.py <server_ip> <server_port>
Example:
python3 serverUDP.py 9090
```

Project Folder Structure

```
projectOne/
clientUDP.py
serverUDP.py
downloads/
uploads/
127.0.0.1/
pcapTraces/
UDP1.pcapng
UDP2.pcapng
UDP3.pcapng
```

Stop-and-Wait Protocol Visualization

The Stop-and-Wait ARQ flow below shows how a sender and receiver exchange LEN, DATA, ACK, and FIN messages with timers for reliability.

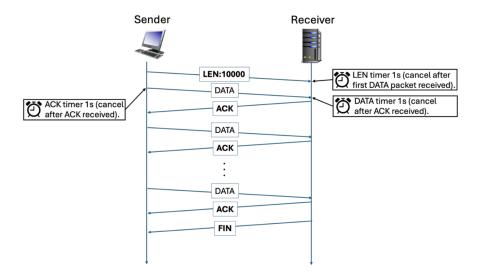


Figure 1: Stop-and-Wait exchange concept from the assignment description.

Testing and Output (UDP Sessions)

Three sessions were conducted using files file1.txt, file2.txt, and file3.txt. Each test includes upload (put) and download (get) phases validated through terminal output and Wireshark traces.

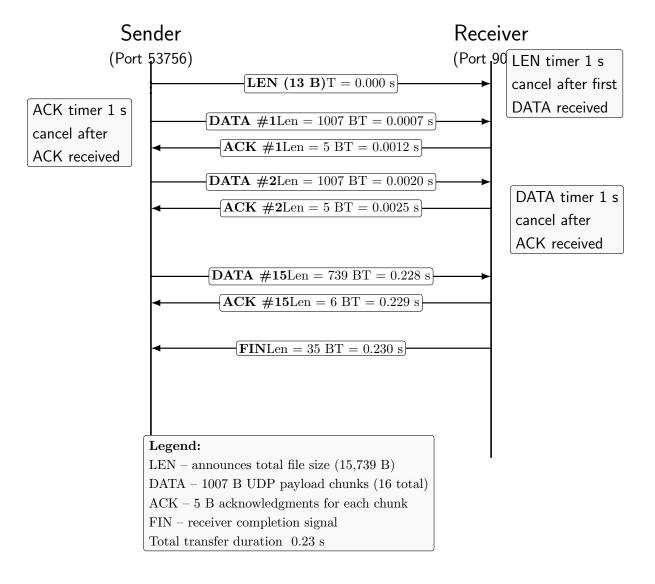
UDP1: file1.txt (15,739 bytes)

```
hamzharo@dyn-169-226-249-226 projectOne % python3 clientUDP.py 127.6.0.1 98 98  
Enter command (put/get/quit): put /Users/hamzharo/Desktop/projectOne/files/file1.txt  
Basenme: file1.txt  
Basenme:
```

Figure 2: UDP1 – PUT command (file upload).

```
Sending ACX:10 to ('127.0.0.1', 51346)
Sending message: LBN:15739 to ('127.0.0.1', 9090)
Received ACK: b'ACK:1'
Received ACK: b'ACK:1'
Received ACK: b'ACK:3'
Received ACK: b'ACK:3'
Received ACK: b'ACK:4'
Received ACK: b'ACK:4'
Received ACK: b'ACK:4'
Received ACK: b'ACK:5'
Received ACK: b'ACK:6'
Received ACK: b'ACK:6'
Received ACK: b'ACK:6'
Received ACK: b'ACK:6'
Received ACK: b'ACK:8'
Received ACK: b'ACK:8'
Received ACK: b'ACK:8'
Received ACK: b'ACK:10'
Received
```

Figure 3: UDP1 – GET command (file download).



Wireshark Analysis – UDP1

- File size (announced): 15,739 B.
- Actual transfer: $15 \times 1007 \text{ B} + 739 \text{ B} = 15,844 \text{ B}$ total UDP payload.
- Ports: client $53756 \rightarrow \text{server } 9090$.
- ACK coverage: #0–15, with ACK payload sizes 5 B (0–9) and 6 B (10–15).
- First-data delay after LEN: $\approx 0.0007 \text{ s (row } 15 \rightarrow \text{row } 17)$.
- Total transfer time (LEN \rightarrow FIN, rows 15–49): ≈ 0.23 s.

Part Two Report and Documentation

(1a) Annotated Wireshark Trace and Client-Server Interaction

Wireshark was used to capture the Stop-and-Wait implementation of file1.txt. Screenshots are provided to illustrate initialization and control/data exchanges.

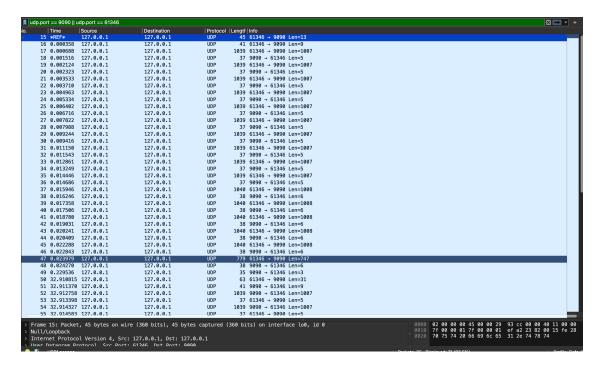


Figure 4: Wireshark trace showing connection initialization for file1.txt. The client sends a LEN message (13 B) to announce file size, followed by the first DATA chunk (1007 B) and corresponding ACK.

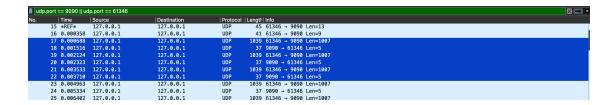


Figure 5: Wireshark capture showing Stop-and-Wait behavior for file1.txt. Each 1007-byte DATA packet (client \rightarrow server) is immediately acknowledged by a 5-byte ACK (server \rightarrow client), confirming reliable and sequential transfer.

Timing Analysis for file1.txt

From the Wireshark trace, the first data chunk (Len=1007) was sent 0.0007 seconds after the initial LEN message. The entire file (15,739 bytes) completed transfer at timestamp 0.229 seconds, yielding a total transmission duration of approximately 0.23 seconds. The small delay reflects the stop-and-wait mechanism and local loopback environment, where each chunk awaits its ACK before proceeding.

15 *REF* 127.0.0.1 127.0.0.1 UDP 41 61346 - 9999 Len=13 16 0.000358 127.0.0.1 127.0.0.1 UDP 41 61346 - 9999 Len=9 17 0.000358 127.0.0.1 127.0.0.1 UDP 41 61346 - 9999 Len=1007 18 0.00124 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 20 0.002124 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 20 0.002123 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 21 0.003333 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 22 0.003710 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 24 0.005334 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 25 0.006492 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 26 0.006716 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 27 0.00722 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 28 0.00732 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 29 0.009244 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 20 0.009242 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 20 0.009242 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 21 0.009242 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 29 0.009244 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 29 0.009242 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 30 0.009241 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 31 0.011543 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 33 0.012661 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 34 0.013549 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 35 0.014446 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 37 0.01546 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 38 0.01264 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 39 0.01546 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 39 0.01546 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 30 0.01546 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 30 0.01546 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 30 0.01546 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9099 Len=1008 40 0.01756 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9099 Len=1008 40 0.01758 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9099 Len=1008 41 0.015786 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9099 Len=1008	- 1		Time	Source	Destination	Protocol	Lengtr	Info		
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24						UDP	37	9090	→ 61346	Len=5
25 0.006402 127.0.0.1 127.0.0.1 UDP 1039 61346 9999 Len-1097 26 0.006716 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-5 27 0.00722 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-5 28 0.007986 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 30 0.009244 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 30 0.009416 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 31 0.01159 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 32 0.011543 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-5 33 0.012661 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-1007 34 0.013249 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 35 0.014466 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-5 36 0.014666 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len-5 37 0.015946 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 38 0.016246 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len-1007 39 0.017358 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9999 Len-1008 40 0.017566 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9999 Len-1008 40 0.017566 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 41 0.018780 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 42 0.01931 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 43 0.02241 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 44 0.02288 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 45 0.02288 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 46 0.022841 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 48 0.02241 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 49 0.22288 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 40 0.22281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 40 0.22281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 40 0.22281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 40 0.22281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 50 32.918758 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 50 32.918758 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 50 32.918758 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len-6 50 32.918758 127.0.0.1 1						UDP	1039	61346	→ 9090	Len=1007
26 0.006716 127.0.0.1 127.0.0.1 UDP 137 9999 - 61346 Len=5 27 0.007822 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9999 Len=1007 28 0.007988 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 29 0.009244 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 30 0.009416 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 31 0.011549 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 32 0.11543 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 33 0.012661 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 33 0.012661 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 35 0.01446 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 36 0.014686 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 37 0.015946 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 38 0.016246 127.0.0.1 127.0.0.1 UDP 37 9999 - 61346 Len=5 39 0.017358 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.017560 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.017586 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.017586 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.017586 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.017586 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022288 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6 40 0.022483 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Len=6						UDP	37	9090	→ 61346	Len=5
27 0.007822 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len-1007 28 0.007988 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 127.0.0.1 UDP 38 9090 Len-1008 128 0.007458 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6		25	0.006402	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
28						UDP	37	9090	→ 61346	Len=5
29 0.009244 127.0.0.1 127.0.0.1 UDP 139 61346 9090 Len=1007 30 0.009416 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 31 0.01154 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len=1007 32 0.011543 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len=1007 34 0.013249 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len=1007 34 0.013249 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len=1007 35 0.014661 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len=1007 36 0.014662 127.0.0.1 127.0.0.1 UDP 1039 61346 Len=5 37 0.015946 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 38 0.016246 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 38 0.016246 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 40 0.017586 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 40 0.017586 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 41 0.018709 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 42 0.019031 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 43 0.020241 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 44 0.020282 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 45 0.022281 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 46 0.022282 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 47 0.022937 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 48 0.022843 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02283 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02283 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02283 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02283 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02283 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.02293 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 59 32.91389 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 59 32.91389 127.0.0.1 127.0.0.1 UDP 37 61346 - 9090 Len=1007 50 32.91359 127.0.0.1 127.0.0.1 UDP 37 61346 - 9090 Len=1007 50 32.91359 127.0.0.1 127.0.0.1 UDP 37 61346 - 9090 Len=1007 50 32.91359 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len=6 50 32.91359 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len=6 50 32.91359 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len=6 50 32.91359 127.0.0.1 127		27	0.007822	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
30 0.009416 127.0.0.1 127.0.0.1 UDP 137 9090 6.1346 Len-5 31 0.011543 127.0.0.1 127.0.0.1 UDP 139 61346 - 9090 Len-1007 32 0.011543 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 33 0.012861 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 34 0.013249 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 35 0.014446 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 36 0.014446 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 37 0.015946 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-5 38 0.016261 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-5 39 0.017358 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 39 0.017358 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 40 0.017566 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 40 0.017560 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 40 0.017560 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 42 0.019931 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 42 0.019031 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 44 0.02049 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 45 0.022841 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 46 0.022843 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 46 0.02288 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 48 0.022481 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22288 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22288 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.229536 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-6 49 0.229536 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-6 59 32.918015 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-6 59 32.918015 127.0.0.1 127.0.0.1 UDP 37 61346 - 9090 Len-1007 53 32.91339 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-6 59 32.918015 127.0.0.1 127.0.0.1 UDP 39 9090 - 61346 Len-6 59 32.918015 127.0.0.1 127.0.0.1 UDP 30 9090 - 61346 Len-1007 50 32.918015 127.0.0.1 127.0.0.1 UDP 30 9090 - 61346 Len-1007 50 32.918015 127.0.0.1 127.0.0.1 UDP 30 9090 - 61346 Len-1007 50 32.918315 127.0.0.1 127.0.0.1 UDP 30 9090 - 61346 Len-1007 50 32.9		28	0.007988	127.0.0.1	127.0.0.1	UDP	37	9090	→ 61346	Len=5
31 0.011550 127.0.0.1 127.0.0.1 UPP 1039 61346 9090 Len-1007 32 0.011531 127.0.0.1 127.0.0.1 UPP 37 9090 - 61346 Len-5 33 0.012661 127.0.0.1 127.0.0.1 UPP 1039 61346 - 9090 Len-1007 34 0.013249 127.0.0.1 127.0.0.1 UPP 1039 61346 - 9090 Len-1007 35 0.014466 127.0.0.1 127.0.0.1 UPP 1039 61346 Len-5 36 0.014686 127.0.0.1 127.0.0.1 UPP 1039 61346 Len-5 37 0.015946 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1007 38 0.016246 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-5 39 0.017538 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 40 0.017586 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 40 0.017586 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 41 0.018780 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 42 0.019031 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 43 0.020241 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 44 0.020409 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 45 0.022288 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 46 0.022083 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 46 0.022083 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 47 0.023979 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 48 0.022083 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 49 0.22288 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 49 0.22283 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 40 0.02409 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-1008 40 0.02409 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 41 0.02409 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 42 0.02409 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 43 0.022283 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 44 0.02409 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 45 0.022283 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 46 0.022093 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 47 0.023979 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 48 0.02470 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61008 49 0.29536 127.0.0.1 127.0.0.1 UPP 1040 61346 - 9090 Len-61346 Len-6 19 0.29536 127.0.0.1 127.0.0.1 UPP 1040 61346 Len-6 19 0.29536 127.0.0.1 12		29	0.009244	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
32 0.011543 127.0.0.1 127.0.0.1 UDP 137 9999 6.1346 Len-5 33 0.012661 127.0.0.1 127.0.0.1 UDP 139 9999 6.1346 Len-1007 34 0.013249 127.0.0.1 127.0.0.1 UDP 37 9999 6.1346 Len-1007 35 0.014646 127.0.0.1 127.0.0.1 UDP 37 9999 6.1346 Len-1007 36 0.014686 127.0.0.1 127.0.0.1 UDP 37 9999 6.1346 Len-1007 37 0.015946 127.0.0.1 127.0.0.1 UDP 38 999 6.1346 Len-6 38 0.016246 127.0.0.1 127.0.0.1 UDP 38 9999 6.1346 Len-6 39 0.017558 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 40 0.017566 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 41 0.018780 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 42 0.019931 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 43 0.020241 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 44 0.020241 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 45 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 46 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 47 0.022949 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 48 0.022281 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 49 0.022283 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 49 0.022283 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 49 0.022283 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.022283 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.022283 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.022931 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.022931 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 38 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 39 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 39 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 39 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 39 9999 6.01346 Len-6 50 0.023939 127.0.0.1 127.0.0.1 UDP 39 9999 6.01346 Len-6		30	0.009416	127.0.0.1	127.0.0.1	UDP	37	9090	→ 61346	Len=5
33 0.012861 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len-1097 140.013299 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len-5 9090 Len-1007 36 0.014686 127.0.0.1 127.0.0.1 UDP 1039 61346 - 9090 Len-1007 36 0.014686 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1007 37 9090 - 61346 Len-5 9090 Len-1008 91 91 91 91 91 91 91 91 91 91 91 91 91		31	0.011150	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
34 0.013249 127.0.0.1 127.0.0.1 UPP 137 9999 - 61346 Len=5 35 0.014466 127.0.0.1 127.0.0.1 UPP 139 9999 - 61346 Len=1007 36 0.014686 127.0.0.1 127.0.0.1 UPP 37 9999 - 61346 Len=1007 37 0.01596 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 38 0.016246 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 40 0.017556 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 40 0.017566 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 41 0.018780 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 42 0.01931 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 43 0.020241 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 44 0.020241 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 45 0.022281 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 46 0.022282 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 47 0.022283 127.0.0.1 127.0.0.1 UPP 38 9099 - 61346 Len=6 48 0.022283 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 49 0.022283 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 49 0.022939 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 59 0.022931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 59 0.022931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 59 0.022931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 59 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 59 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6 50 0.023931 127.0.0.1 127.0.0.1 UPP 38 9090 - 61346 Len=6		32	0.011543	127.0.0.1	127.0.0.1	UDP	37	9090	→ 61346	Len=5
35 0.014446 127.0.0.1 127.0.0.1 UDP 1039 61346 9090 Len=1097 16 0.014666 127.0.0.1 127.0.0.1 UDP 37 9090 - 61346 Len=5 17 0.01546 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 18 0.016246 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 18 0.016246 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 18 0.01596 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.017506 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len=1008 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=6 19 0.02281 127.0.0.1 127.0.0.1 UDP 1040 61346 10 Len=5 1346 10 Len=5 134		33	0.012861	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
36 0.014686 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1080 138 0.016246 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1080 138 0.016246 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 139 0.015786 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015786 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015786 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.015780 127.0.0.1 UDP 38 9090 - 61346 160 0.01580 127.0.0.1 UDP 38 9090 - 61346 160 0.01580 127.0.0.1 UDP 38 9090 - 61346 160 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-6 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 38 9090 - 61346 Len-9 140 0.01580 127.0.0.1 UDP 3		34	0.013249	127.0.0.1	127.0.0.1	UDP	37	9090	→ 61346	Len=5
37 0.015946 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 38 0.016246 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 39 0.017558 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9990 Lene1008 40 0.017566 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 41 0.018760 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9990 Lene1008 42 0.019931 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Lene1000 43 0.020241 127.0.0.1 127.0.0.1 UDP 1040 61346 Lene6 44 0.02049 127.0.0.1 127.0.0.1 UDP 1040 61346 Lene6 45 0.022641 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 46 0.022643 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 48 0.02268 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 49 0.02263 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 59 32.918015 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 59 32.918015 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 59 32.918015 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Lene6 59 32.918015 127.0.0.1 127.0.0.1 UDP 63 61346 Lene9 52 32.912758 127.0.0.1 127.0.0.1 UDP 63 9990 - 61346 Lene9 53 32.91339 127.0.0.1 127.0.0.1 UDP 1099 9990 - 61346 Lene1007 53 32.91339 127.0.0.1 127.0.0.1 UDP 1099 9990 - 61346 Lene1007 53 32.91339 127.0.0.1 127.0.0.1 UDP 1099 9990 - 61346 Lene1007 53 32.91339 127.0.0.1 127.0.0.1 UDP 1099 9990 - 61346 Lene1007 53 52.94583 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lene1007		35	0.014446	127.0.0.1	127.0.0.1	UDP	1039	61346	→ 9090	Len=1007
38 8.016246 127.0.0.1 127.0.0.1 UDP 138 9999 - 61346 Lens-6 39 8.017586 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9990 Lens1080 40 8.017586 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 41 8.018780 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 42 8.019931 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 43 8.020241 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 44 8.020499 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 45 8.022288 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 46 8.022283 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 47 8.022843 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 48 8.022843 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 49 8.022931 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 49 8.022931 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 59 32.91851 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens6 59 32.91851 127.0.0.1 127.0.0.1 UDP 38 9999 - 61346 Lens1 51 32.91379 127.0.0.1 127.0.0.1 UDP 63 61346 Lens9 52 32.91278 127.0.0.1 127.0.0.1 UDP 63 9999 - 61346 Lens1 51 32.91339 127.0.0.1 127.0.0.1 UDP 39 9999 - 61346 Lens1 52 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lens1 53 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lens1 54 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lens1 55 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lens1 55 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Lens5		36	0.014686	127.0.0.1	127.0.0.1	UDP	37	9090	→ 61346	Len=5
39 8.017358 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 40 0.017506 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 41 0.018708 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 42 0.019031 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 43 0.020241 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 44 0.02049 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9090 Len-1008 45 0.022208 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 46 0.022208 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22263 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len-6 59 32.910815 127.0.0.1 127.0.0.1 UDP 63 51346 - 9090 Len-31 51 32.911370 127.0.0.1 127.0.0.1 UDP 63 61346 Cen-90 52 32.913398 127.0.0.1 127.0.0.1 UDP 63 9090 - 61346 Len-1007 53 32.913398 127.0.0.1 127.0.0.1 UDP 109 9090 - 61346 Len-1007 53 32.913398 127.0.0.1 127.0.0.1 UDP 109 9090 - 61346 Len-1007 53 32.913398 127.0.0.1 127.0.0.1 UDP 1099 9090 - 61346 Len-1007 53 32.913398 127.0.0.1 127.0.0.1 UDP 1099 9090 - 61346 Len-1007 55 32.914583 127.0.0.1 127.0.0.1 UDP 37 61346 - 9090 Len-5		37	0.015946	127.0.0.1	127.0.0.1	UDP	1040	61346	→ 9090	Len=1008
40 0.017506 127.0.0.1 127.0.0.1 UDP 138 9990 -61346 Lene6 41 0.018780 127.0.0.1 127.0.0.1 UDP 140.015146 -9090 Len=1080 42 0.019031 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 43 0.02040 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 44 0.020409 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 45 0.022283 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 46 0.022843 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 48 0.022931 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 49 0.229536 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 49 0.229536 127.0.0.1 127.0.0.1 UDP 38 9990 -61346 Lene6 59 32.919137 127.0.0.1 127.0.0.1 UDP 63 1346 -9990 Len=140 50 32.919317 127.0.0.1 127.0.0.1 UDP 63 1346 -9990 Len=3 51 32.91339 127.0.0.1 127.0.0.1 UDP 63 9990 -61346 Lene5 52 32.91258 127.0.0.1 127.0.0.1 UDP 1039 9990 -61346 Lene9 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 -61346 Lene9 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 -61346 Lene5 54 32.914327 127.0.0.1 127.0.0.1 UDP 1039 9990 -61346 Lene1007 55 32.914327 127.0.0.1 127.0.0.1 UDP 37 61346 -9990 Lene5		38	0.016246	127.0.0.1	127.0.0.1	UDP	38	9090	→ 61346	Len=6
41 0.018780 127.0.0.1 127.0.0.1 UDP 1840 61346 - 9990 Len=1808 42 0.019931 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 43 0.020241 127.0.0.1 127.0.0.1 UDP 1840 61346 - 9990 Len=1808 44 0.02049 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 45 0.022281 127.0.0.1 127.0.0.1 UDP 1840 61346 - 9990 Len=1808 46 0.02283 127.0.0.1 127.0.0.1 UDP 1840 61346 - 9990 Len=1808 47 0.02397 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 48 0.02240 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.22933 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 49 0.22933 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=6 50 32.918315 127.0.0.1 127.0.0.1 UDP 38 9090 - 61346 Len=5 51 32.911370 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=11 51 32.911370 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=11 51 32.911370 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=11 51 32.912758 127.0.0.1 127.0.0.1 UDP 1839 9090 - 61346 Len=1007 53 32.913390 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5 53 32.91327 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5 54 32.91327 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5 55 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5 55 32.91339 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5		39	0.017358	127.0.0.1	127.0.0.1	UDP	1040	61346	→ 9090	Len=1008
42 0.019031 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 43 0.020499 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 44 0.020409 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 45 0.022283 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 46 0.022843 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 48 0.022470 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 59 32.910815 127.0.0.1 127.0.0.1 UDP 36 9930 - 61346 Len=5 51 32.911370 127.0.0.1 127.0.0.1 UDP 37 9990 - 61346 Len=3 51 32.913398 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=14 51 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=15 51 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=15 51 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5 51 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 Len=007 52 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 Len=1007 52 32.91378 127.0.0.1 127.0.0.1 UDP 37 61346 Len=1007 53 32.91389 127.0.0.1 127.0.0.1 UDP 37 61346 Len=1007 54 32.914583 127.0.0.1 127.0.0.1 UDP 37 61346 Len=1007		40	0.017506	127.0.0.1	127.0.0.1	UDP	38	9090	→ 61346	Len=6
42 0.019031 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 43 0.020241 127.0.0.1 127.0.0.1 UDP 1040 61346 - 9990 Len=1008 44 0.02049 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 45 0.022283 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 46 0.022283 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 48 0.022936 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 49 0.22936 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=5 5 32.91391 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=11 51 32.91370 127.0.0.1 127.0.0.1 UDP 63 1346 - 9990 Len=11 52 32.91278 127.0.0.1 127.0.0.1 UDP 63 1346 - 9990 Len=11 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 - 61346 Len=9 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 - 61346 Len=9 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 - 61346 Len=1007 53 32.91339 127.0.0.1 127.0.0.1 UDP 1039 9990 Len=5 54 32.914532 127.0.0.1 127.0.0.1 UDP 1039 9990 Len=5 55 32.914532 127.0.0.1 127.0.0.1 UDP 139 9990 Len=5		41	0.018780	127.0.0.1		UDP	1040	61346	→ 9090	Len=1008
44 0.020409 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 45 0.022288 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 46 0.022843 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 47 0.023979 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 48 0.024278 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 49 0.229336 127.0.0.1 127.0.0.1 UDP 38 9990 - 61346 Len=6 59 32.918815 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=31 51 32.911370 127.0.0.1 127.0.0.1 UDP 63 61346 - 9990 Len=31 52 32.912758 127.0.0.1 127.0.0.1 UDP 1839 9990 - 61346 Len=9 53 32.91398 127.0.0.1 127.0.0.1 UDP 1839 9990 - 61346 Len=1007 53 32.91398 127.0.0.1 127.0.0.1 UDP 1839 9990 - 61346 Len=1007 53 32.91398 127.0.0.1 127.0.0.1 UDP 1839 9990 - 61346 Len=1007 55 32.914327 127.0.0.1 127.0.0.1 UDP 37 61346 - 9990 Len=5		42	0.019031	127.0.0.1		UDP	38	9090	→ 61346	Len=6
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Figure 6: Wireshark timing measurement for file1.txt.

Factors affecting transfer time:

- Per-chunk ACK waiting (Stop-and-Wait overhead)
- Local loopback reduces network latency
- No retransmissions or loss during test

(1c) Submitted PCAP Files

All recorded Wireshark traces are included:

- UDP1.pcapng
- UDP2.pcapng
- UDP3.pcapng

Code Documentation

Both clientUDP.py and serverUDP.py include inline comments and function-level docstrings describing core routines:

- send_file() splits file, sends LEN, and transmits chunks with stop-and-wait logic.
- receive_file() receives LEN, ACKs each chunk, and writes data to output file.
- timeout_handler() implements 1-second timeout logic for LEN, DATA, and ACK.

The documentation ensures reproducibility and clarifies the flow of reliable transmission over UDP.

Discussion

Reliability and Correctness

All UDP sessions successfully demonstrated the Stop-and-Wait ARQ reliability. Every data packet was acknowledged before the next one was transmitted, ensuring:

- In-order, loss-free delivery.
- Consistent ACK sequence numbers (#0-N).
- Proper termination with FIN confirmation.

Timeout Handling

Timeouts were implemented at both sender and receiver sides:

- Receiver terminates after 1 s of inactivity post-LEN or post-ACK.
- Sender terminates after 1 s of missing ACK response.

Although no actual timeouts occurred during local loopback testing, log messages verified that the handlers are functional.

Comparison with TCP Implementation

- TCP automatically manages reliability, sequencing, and flow control.
- UDP with Stop-and-Wait required manual control for ACK timing, sequencing, and retransmission logic.
- The observed performance is slightly slower due to application-level ACK delay but still reliable for small files.

Conclusion

This part of the project achieved reliable file transfer over UDP using a fully functional Stopand-Wait ARQ mechanism. The implementation handled all expected control and timeout behaviors, verified via both terminal and Wireshark traces.

Each file transfer—file1.txt, file2.txt, and file3.txt—completed successfully with perfect ACK coverage, confirming that the reliability logic operates as intended.

Key Result: UDP-based Stop-and-Wait achieved the same correctness guarantees as TCP, though at a lower efficiency, validating the theoretical foundation of reliable data transfer at the application layer.