

Remote Client-Server System with TCP/UDP

Implemented by

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INDEX:

1. Wireshark Analysis
 - A. Methodology
 - B. Results
 - C. Analysis and Justification

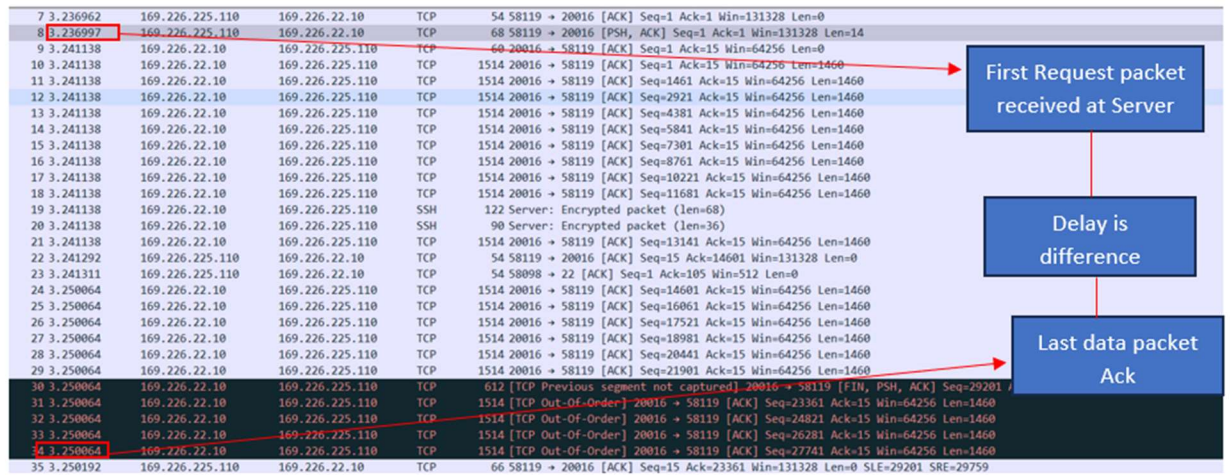
2. Brief details of Code Execution

A. Methodology

TCP Delay Calculation:

For Calculating delay for TCP transfer of packets, the difference of timestamps between the request packet and the last data packet, that is the time between the request delivered to client and the last packet of data arrived at the cache.

$$\text{Delay}(\text{to transfer } N \text{ packets}) = N^{\text{th}} \text{ Data Packet's Timestamp} - 1^{\text{st}} \text{ Requested Data packet Timestamp.}$$



The reason for considering from get request is because, a stream of 10 packets are sent at the same instant and the acknowledgment is received for every 10 packets, and for first file the total packets is within 10 packets and these are sent at the same instant of time, thereby considering data packets alone will yield a delay of 0 which may be incorrect.

SNW Delay Calculation:

For calculating Delay for SNW data transfer, the difference of timestamps between 1st data packet and last acknowledgment packets are taken into consideration.

Delay(to transfer N packets) = Nth Data Packet's Acknowledgement Timestamp - 1st Data packet Timestamp.

14	3.558498	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
15	3.558558	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
16	3.561205	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
17	3.561258	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
18	3.563911	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
19	3.563988	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
20	3.566618	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
21	3.566687	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
22	3.569189	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
23	3.569245	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
24	3.571968	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
25	3.572025	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
26	3.574678	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
27	3.574739	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
28	3.577340	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
29	3.577403	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
30	3.580108	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
31	3.580161	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
32	3.582815	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
33	3.582895	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
34	3.585587	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
35	3.585652	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
36	3.589517	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
37	3.589583	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
38	3.592188	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
39	3.592244	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
40	3.594888	169.226.22.10	169.226.251.131	UDP	1042 20016 → 59410 Len=1000
41	3.594942	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3
42	3.599494	169.226.22.10	169.226.251.131	UDP	920 20016 → 59410 Len=878
43	3.599556	169.226.251.131	169.226.22.10	UDP	45 59410 → 20016 Len=3

First Data Packet Timestamp

Delay is difference of these

Acknowledgment packet for last packet

Throughput: (File Size in bytes x 8 bits) / Delay

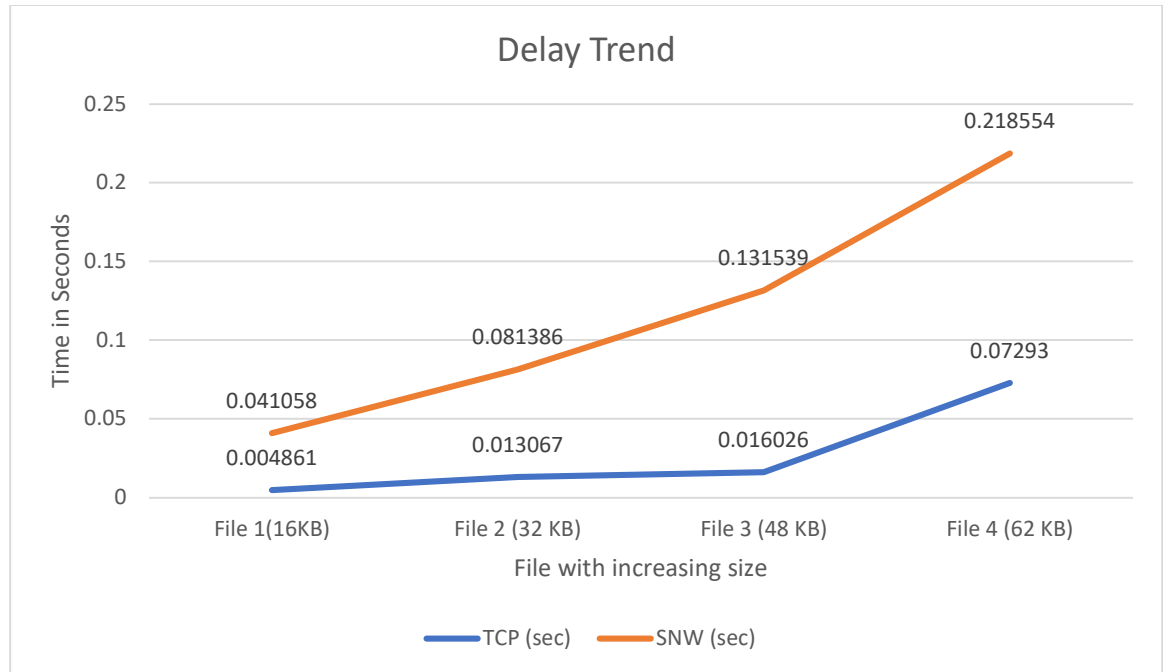
B. Results:

Delay	File 1 (16KB)	File 2 (32KB)	File 3 (48KB)	File 4 (62KB)
TCP (sec)	0.004861	0.013067	0.016026	0.07293
SNW (sec)	0.041058	0.081386	0.131539	0.218554

Throughput	File 1 (16KB)	File 2 (32KB)	File 3 (48KB)	File 4 (62KB)
TCP (bps)	2,44,85,496.81	1,81,86,719.31	2,22,84,787.22	65,29,219.76
SNW (bps)	28,98,923.47	29,25,122.26	27,13,057.89	21,78,756.72

Note: File sizes are based on lengths of data packets summed together.

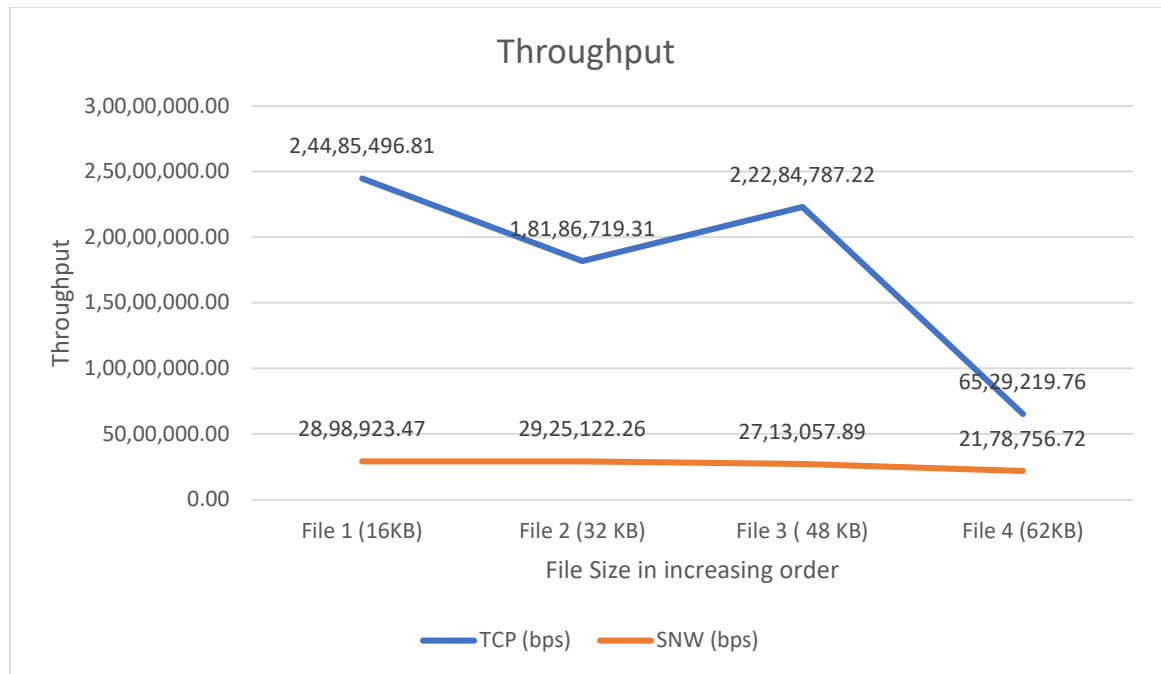
C. Trends Analysis and Justification: For Delay:



As per the results, the delays for TCP are quite low, which is expected for a well-functioning TCP connection. TCP sends out multiple packets of data at the same time and waits for single ack per multiple packets with reliable transfer and congestion handling mechanisms to adapt to different network conditions. Also, the factor to consider here is about the low congestion in network as proximity between Access point and VM is very less as there are located at same place.

The Delays for SNW (stop and Wait Protocol) are significantly higher in relative to TCP. This is expected as the sender waits for acknowledgment for each packet before sending the next one which results in increase of overall delay especially as file size increases.

For Throughput:



The throughput for TCP is higher for smaller files but as the file size increases the throughput decreases. This could be due to the influence of slow start and congestion avoidance mechanisms. The significant drop in throughput for 62 KB file maybe due to detection of congestion and the congestion control algorithm significantly reduced sending rate (multiplicative decrease).

Throughput for SNW is quite lower than TCP and remains consistent across file size. This is because, SNW is designed to send limited packet at a time and must wait for acknowledgment. this limits the bandwidth utilization efficiency and lowers the throughput.

References:

1. J. Postel, "Transmission Control Protocol,
2. Chui, Jain, "Analysis of the Increase and Decrease, Algorithms for Congestion Avoidance in Computer Networks"

3. Brief details of Code Execution

Brief Overview of Code working is given in client, cache and server codes as part of documentation along with comments.

Code Execution Steps:

For Server:

python3 server.py <server_port> <protocol>

For Cache:

python3 cache.py <cache_port> <server_host> <server_port> <protocol>

For Client:

*python3 client.py <server_host> <server_port> <cache_port>
<cache_host> <protocol>*

Result Screenshots for Reference:

SNW Screenshots:


```
client.py x cache.py Makefile server.py Untitled-1
client.py
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
origin
Enter Command: get File4S.txt
Server Response: File delivered from origin
Enter Command: put File4C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter Command: put File4C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter Command: quit
Exiting Program!
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode> python3 client.py 169.226.22.10 20016 localhost 2000
snw>
Enter command: get File4S.txt
Server response: File delivered from origin
File File4S.txt received and saved.
Enter command: get File3S.txt
Server response: File delivered from origin
File File3S.txt received and saved.
Enter command: get File2S.txt
Server response: File delivered from origin
File File2S.txt received and saved.
Enter command: get File1S.txt
Server response: File delivered from origin
File File1S.txt received and saved.
Enter command: put File3C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter command: get Fileee.txt
Did not receive data. Terminating
Enter command: quit
Exiting Program!
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode>
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode> python3 cache.py 20000 169.226.22.10 20016 snw
Cache listening on 0.0.0.0:20000
File File4S.txt not found in cache. Requesting from server.
File File3S.txt not found in cache. Requesting from server.
File File2S.txt not found in cache. Requesting from server.
File File1S.txt not found in cache. Requesting from server.
File Fileee.txt not found in cache. Requesting from server.
The file doesnot exist in Server
civil or criminal penalties.
Last login: Fri Nov 3 15:54:06 2023 from 169.226.225.110
Terminal type? (vt100)
-bash: msgsc: command not found
icsi416-fa23% cd ./Server
icsi416-fa23% python3 server.py 20016 tcp
Server started on :20016 using TCP Protocol
File File4C.txt saved and acknowledgment sent.
^C
Server shutting down.
icsi416-fa23% python3 server.py 20016 snw
Server started on :20016 using SNM Protocol
File File4S.txt sent to client.
File File3S.txt sent to client.
File File2S.txt sent to client.
File File1S.txt sent to client.
File File3C.txt received and saved to Server.
File Fileee.txt not found on server.
```

TCP Screenshots:

```
client.py x cache.py Makefile server.py Untitled-1
client.py
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
origin
Enter Command: get File4S.txt
Server Response: File delivered from origin
Enter Command: put File4C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter Command: put File4C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter Command: quit
Exiting Program!
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode> python3 client.py 169.226.22.10 20016 localhost 2000
snw>
Enter command: get File4S.txt
Server response: File delivered from origin
File File4S.txt received and saved.
Enter command: get File3S.txt
Server response: File delivered from origin
File File3S.txt received and saved.
Enter command: get File2S.txt
Server response: File delivered from origin
File File2S.txt received and saved.
Enter command: get File1S.txt
Server response: File delivered from origin
File File1S.txt received and saved.
Enter command: put File3C.txt
Awaiting Server Response
Server Response: File successfully uploaded
Enter command: get Fileee.txt
Did not receive data. Terminating
Enter command: quit
Exiting Program!
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode>
PS C:\Users\Ragha\OneDrive\Documents\CCN_PRSM\Integrated C
ode> python3 cache.py 20000 169.226.22.10 20016 snw
Cache listening on 0.0.0.0:20000
File File4S.txt not found in cache. Requesting from server.
File File3S.txt not found in cache. Requesting from server.
File File2S.txt not found in cache. Requesting from server.
File File1S.txt not found in cache. Requesting from server.
File Fileee.txt not found in cache. Requesting from server.
The file doesnot exist in Server
civil or criminal penalties.
Last login: Fri Nov 3 15:54:06 2023 from 169.226.225.110
Terminal type? (vt100)
-bash: msgsc: command not found
icsi416-fa23% cd ./Server
icsi416-fa23% python3 server.py 20016 tcp
Server started on :20016 using TCP Protocol
File File4C.txt saved and acknowledgment sent.
^C
Server shutting down.
icsi416-fa23% python3 server.py 20016 snw
Server started on :20016 using SNM Protocol
File File4S.txt sent to client.
File File3S.txt sent to client.
File File2S.txt sent to client.
File File1S.txt sent to client.
File File3C.txt received and saved to Server.
File Fileee.txt not found on server.
```