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**ASSIGNMENT 2 - PART A**

**HIGH LEVEL VIEW of “analysis\_pcap\_tcp” Code**

I open assignment2.pcap file in binary format for reading it.

Next, I create a structure for Packet, which would have the fields header size, source IP address, destination IP address, source port number, destination port number, syn flag, ack flag, fin flag, window size, sequence number, acknowledgement number, packet size, timestamp, maximum segment size, payload and length of the payload.

Hence I can now get the packets from the pcap file.

On analysing I found that there are 3 different source port numbers which signifies there are three flows.

I divide all packet transactions into three arrays according to the flow.

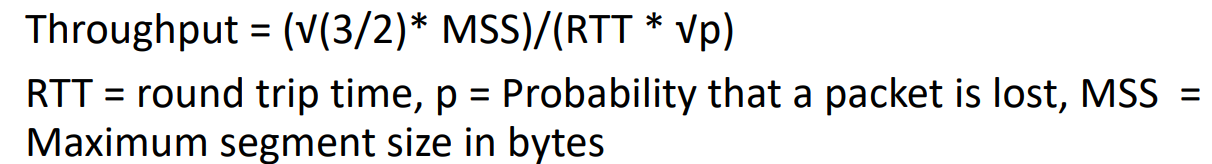
For each flow, I print the first two transactions from the sender to receiver (n 130.245.145.12 to 128.208.2.198).

Next, I calculate the throughput on the receiver end for each flow by checking the total amount of data sent divided by the time from which the sending process started till the time at which the sending process ended.

Further, I move forward to calculate the Loss Rate for each flow. For calculating the loss rate for each flow, I take the total number of packets sent in that flow, subtract the unique packets (for the same flow) from it and divide this number obtained by the total number of packets sent (in that flow).

Then I move ahead to calculate the average round trip time (RTT). For each flow, I check the sequence number sent, and add the data length to it to find the expected acknowledgement number. Now I have the sequence number and acknowledgement number. I search the ack number in the file to see when the ack was received. If the sequence number is transmitted more than one time, I ignore that in RTT calculations following the KARN’s algorithm. I add RTT for each transaction in a queue and once I have evaluated all the transactions for a flow, I take an average of all the RTTs by summing them up and dividing by the total number of RTTs.

Finally, from the values obtained from the above functions, we calculate the theoretical throughput using the formula discussed in class. The formula used is:



**The answers to each question using the methods discussed above in the high level view:**

1. Count the number of TCP flows initiated from the sender.

ANS:

**TOTAL NUMBER OF FLOWS OBSERVED: 3**

**43498 to 80**

**43500 to 80**

**43502 to 80**

1. For each TCP flow
2. For the first 2 transactions after the TCP connection is set up (from sender to receiver), get the values of the Sequence number, Ack number, and Receive Window size. Use the raw values for the sequence number and ack number. Explain these values.

ANS:

**FOR FLOW 1**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 705669103 ACKNOWLEDGEMENT NUMBER 1921750144 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 1921750144 ACKNOWLEDGEMENT NUMBER 705669127 WINDOW SIZE 49152**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 705669127 ACKNOWLEDGEMENT NUMBER 1921750144 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 1921750144 ACKNOWLEDGEMENT NUMBER 705670575 WINDOW SIZE 49152**

**FOR FLOW 2**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 3636173852 ACKNOWLEDGEMENT NUMBER 2335809728 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 2335809728 ACKNOWLEDGEMENT NUMBER 3636173876 WINDOW SIZE 49152**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 3636173876 ACKNOWLEDGEMENT NUMBER 2335809728 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 2335809728 ACKNOWLEDGEMENT NUMBER 3636175324 WINDOW SIZE 49152**

**FOR FLOW 3**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 2558634630 ACKNOWLEDGEMENT NUMBER 3429921723 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 3429921723 ACKNOWLEDGEMENT NUMBER 2558634654 WINDOW SIZE 49152**

**################SENDING PACKET####################**

**SEQUENCE NUMBER 2558634654 ACKNOWLEDGEMENT NUMBER 3429921723 WINDOW SIZE 49152**

**################RECEIVING ACK####################**

**SEQUENCE NUMBER 3429921723 ACKNOWLEDGEMENT NUMBER 2558636102 WINDOW SIZE 49152**

1. Compute the throughput at the receiver. You can make assumptions on what you want to include as part of the throughput estimation.

ANS:

**FOR FLOW 1**

**THROUGHPUT: 5.251391112912558 Mbps**

**FOR FLOW 2**

**THROUGHPUT: 1.285420726825806 Mbps**

**FOR FLOW 3**

**THROUGHPUT: 1.4815063848257195 Mbps**

1. Compute the loss rate for each flow. Loss rate is the number of packets not received divided by the number of packets sent. Loss rate is an application layer metric. So think about what makes sense when defining loss rate.

ANS:

**FOR FLOW 1**

**LOSS RATE: 0.0004299842339114232**

**FOR FLOW 2**

**LOSS RATE: 0.013299377475947935**

**FOR FLOW 3**

**LOSS RATE: 0.0**

1. Estimate the average RTT. Now compare your empirical throughput from (b) and the theoretical throughput (estimated using the formula derived in class). Explain your comparison

ANS:

**FOR FLOW 1**

**AVERAGE RTT 0.07352114802099784**

**FOR FLOW 2**

**AVERAGE RTT 0.08857328554621063**

**FOR FLOW 3**

**AVERAGE RTT 0.0731122042113989**

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**FOR FLOW 1**

**THEORETICAL THROUGHPUT: 1.1728971731440423 Mbps**

**FOR FLOW 2**

**THEORETICAL THROUGHPUT: 0.17505723887542693 Mbps**

**FOR FLOW 3**

**THEORETICAL THROUGHPUT: Infinity Mbps**