

Assignment 2: Transport Layer and Network Simulations using NS-3

Deadline: 19th October 2023, 11:59 PM

Goal of the Assignment:

Study and understand Transport layer protocol using Wireshark and other tools. Study and understand different TCP variants using NS-3 and by reading research articles.

Part 1: Wireshark/tshark/tcpdump [23 Points]

1. Download a large file (Ubuntu image from the **Internet**). 60 seconds of observation is sufficient. Plot the following metrics from Wireshark and write inferences.
 - a. Plot the estimated Round Trip Time (RTT) variation for the download **[2 Points]**
 - b. Plot the TCP Congestion window (or the difference in ack numbers - bytes delivered) for the download. X-axis is time, and Y-axis is bytes delivered (X ticks for each RTT, hence sum up the bytes delivered over each RTT). **[3 Points]**
 - c. Get the flow graph (Statistics - flow graph) **[2 Points]**.
 - d. What is the average throughput observed **[2 Points]**.
 - e. Plot the receiver congestion window advertised over time **[2 Points]**.
 - f. Plot the number of 1-duplicate ack, 2-duplicate ack, and 3-duplicate acks received over time **[1+1+1=3 Points]**.
2. Download a small file and identify the TCP 3-way handshake. **[3 Points]**
3. Ping a host and capture the packets with Wireshark. What kind of packets are generated by the ping command? **[3 Points]**
4. Use nmap (using command `nmap -PS [neighbor's ip address]`) to perform the host scan (same as used in the previous question) and capture the packets with Wireshark. What kind of packets are generated by Nmap? **[3 Points]**

Part 2: Study of TCP Congestion Control Algorithms [20 Points]

Explain and compare any four TCP congestion control algorithms (TCP Variants).

Out of four TCP congestion control algorithms, one must be TCP Cubic, and at least one algorithm should be from loss-based, delay-based, and hybrid categories. Definitions of these categories are given below, and some of the TCP variants are shown in the table.

1. Loss-based TCP variants use packet loss as an indication of Congestion.
2. Delay-based TCP variants consider packet delay rather than packet loss as congestion in the network.
3. In the hybrid type of TCP variant, both packet loss and delay of the packet are considered as congestion in the network.

Category	TCP Variants
Loss Based & Loss + Estimation	TCP-Tahoe, TCP-Reno, TCP- New Reno, TCP-SACK, TCP-FACK, , BIC-TCP, TCP Cubic , TCP Hybla TCP, HS-TCP, H-TCP, S-TCP, LP, TCP Libra , TCP Westwood , TCPW CRB, TWPW BR, DOOR,DSACK, TD FR, TCP -FIT
Delay Based	TCP-Vegas , TCP Vegas-A, TCP New Vegas, FAST-TCP, Nice, TCP Real
Hybrid(Loss & Delay) Based & L+D+ Estimation	Compound TCP, , TCP Jersey , TCP Africa, TCP Veno , TCP Illinois', YeAH TCP, TCP Fusion, , TCP-FNC,TCP-ACC

Note: Refer to research papers for different algorithms. The report should have the following points.

- ➔ Algorithm Details
- ➔ Suitable for which scenarios and where it fails
- ➔ Compare all four variants in the end and write inferences

Note for Part 2: Do not copy and paste from the paper, understand the algorithms. This assignment will be evaluated through a presentation by students. TAs can randomly pick some students and ask them to present the submitted report for evaluation.

Part 3: Understanding TCP Congestion Window using NS-3 [35 Points]

1. For each of the given congestion control algorithms, perform the simulations and answer the following questions. (Demo.cc file is provided) **[20 Points]**

- a. Newreno
- b. Highspeed
- c. Veno
- d. Vegas

Q1. Plot the cwnd vs time graph, and describe what you observed, like slow start and congestion avoidance, in detail.

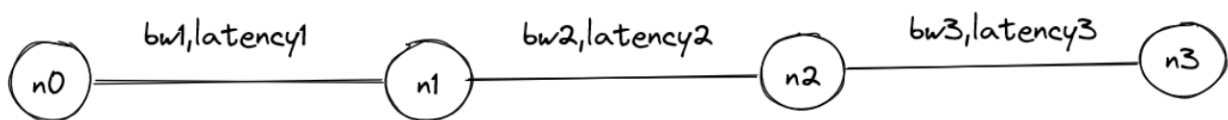
Q2. Find the average throughput for each of the congestion control algorithms using tshark from the pcap files generated, and state which algorithm performed the best.

Q3. How many times did the TCP algo reduce the cwnd and why?

Q4. Check the effect of changing the bandwidth and latency of point-to-point connection and explain its effect on average throughput.

Q5. Explain in short what is the effect of changing the default MTU size.

2. Using the Demo.cc file as reference, create a new scenario topology consisting of 4 nodes as shown below. **[15 Points]**



In order to do this you must first create 4 nodes with 3 links. Nodes can have multiple interfaces to connect to different links. Divide the topology into 3 sub-networks node 0 and node 1 in subnetwork 1(10.1.1.0/24), node 1 and node 2 in subnetwork 2(10.1.2.0/24) and node 2 and node 3 in subnetwork 3(10.1.3.0/24), and use IPv4GlobalRoutingHelper to populate the routing tables which can be done using

```
Ipv4GlobalRoutingHelper::PopulateRoutingTables();
```

Q1. Find the average throughput for the given parameters.

bw1 = 5mbps, latency1 = 2ms

bw2 = 5mbps, latency2 = 2ms

bw3 = 5mbps, latency3 = 2ms

Q2. Now change the values of latency2 from 2ms to 10ms and plot and compare the cwnd shape. Do this for two different congestion control algorithms.

Deliverables in a tar ball on GC:

- Submission Guidelines: For each part, create a separate folder. Upload all the folders and Assignment Report in GC as a tarball with the file name as <your roll no>_<your name>.tar
- Readable Report [2 Marks for report quality] enumerating steps followed with screenshots for each of the important steps.
 - Link to download the collected Pcap trace and mention the command/tool used.
 - Put the screenshots in the report for better clarity
- For all the experiments, write the inferences that you have observed.
- If you want, you can use the CAPTCP [TCP Analyzer] tool or any other tool for Part 1.

[Check Web sources for more information](#)