NS Lab 4 Assignment

NS3 simulator - TCP Performance Monitoring

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Total points: 20 pts

Abstract

This assignment teaches you how to monitor the performance of the TCP protocol using the ns-3 simulator. Before to start doing this assignment, study the ns-3 tutorial.

Note: You can find *NS3* at the following directory in the linux lab machines:
`/opt/linux-x86_64/ns-allinone-3.17`

Task 1 – Throughput of TCP client-server connection

In this task you are going to measure the throughput, while tuning the TCP receive windows size and the link latency.

Preparation:

Download the source template (lab4-task1-template.cc) and develop a simulation scenario. Please provide your code only at the pre-defined positions, where the *//TODO* comments are in place.

Steps:

1. Create a simple topology of two nodes: N1 and N2 connected by a point-to-point link: bandwidth 3.2Mbps, 64ms latency (latency = one-way delay).
2. Set maximum receive window size (RWIN) to 16384 bytes.
3. Install a TCP client application on N1 and a TCP server application on N2 with data sending rate 2Mbps.
4. Start the client application at time 1s and stop it at time 50s. Measure the throughput.

5. Change the latency to 96ms and 128ms, measure equivalent throughput values.

Questions:

1. For each one of the latencies (64ms, 96ms and 128ms), give the measured throughput and the calculated throughput (calculate it on paper and provide also your calculations). Use the RWIN size and the latency, to compute the throughput each time.
2. Does the latency effect throughput? Explain the results.
3. Is there any optimal RWIN value to obtain maximal throughput? Calculate it, on paper, for the scenario 3.2Mbps bandwidth, 64ms latency.
4. Measure the throughput for the found optimal RWIND and the configuration of question 3. What is the measured throughput? (*Note*: also, update the data sending rate of the application)

Task 2 – Monitoring TCP congestion window

This task monitors congestion window changes over times and analyze TCP phases.

Preparation:

Download and develop simulation based on the template file *lab4-task2-template.cc*. Please provide your code only at the pre-defined positions, where the *//TODO* comments are in place.

Note: If you want to use the gnuplot then you can use the sample gnuplot script (plot.gnu) to plot graph from data log.

Steps:

1. Create a network topology containing two nodes N0 — N1, connected by a point-to-point link 5Mbps bandwidth, 16ms latency.
2. Configure simulation scenario, set the TCP stack using TCP Tahoe algorithm and disable delay ACK.
3. Install a TCP socket instance on node N0 connecting to node N1: data rate 5Mbps, packet size 1400 bytes.
   Note: Because we want to monitor CWND changes of the TCP socket, using on-off application is not possible. We need to do following:
   a. Create a TCP socket server using PacketSinkHelper class

b. Utilize class MyApp in the template code, by creating a TCP socket client directly and bind to a MyApp object to send data to the server. (Already included in the template code)

4. Set simulation time from 0s to 50s.
5. Start the TCP server at time 0.5s, TCP client at time 1.0s.
6. Monitor congestion window changes over time.
7. Set droptail queue size of the buffer in the TCP stack to 40 packets and run simulation again. Monitor congestion window changes.
8. Record CWND in the two simulation scenarios. Use gnuplot, MS Excel or whichever else plotting application you like, to visualize the requested graphs.

Questions:

1. Describe the first graph (no more than 3-4 lines), with the default droptail queue. Explain where you see the slow-start and congestion-avoidance states (for the change points give the times and cwnd).
2. For the graph with droptail queue = 40:
    a. Plot the graph from 1 second until the 50 seconds.
    b. Plot the graph from 1^{st} second until the 1.85^{th} second. Try to identify where a state-change is happened. For each change, fill the table (in the answer sheet) with the change time, the cwnd size at the time of change and the new state. Provide also the initial state. (Optionally and additionally with the table, you can give a brief description, but not more than 3 lines).
    c. Plot the graph from the 4^{th} second until the 6^{th} second. Fill the table in the same way, like question 2.b. (Optionally and additionally with the table, you can give a brief description, but not more than 3 lines).
3. Perform similar experiment with droptail queue setting 40 packets for other TCP variant: Reno.
    a. Plot the graph from 1 second until the 50 seconds.
    b. Plot the graph from 4^{th} second until the 6^{th} second. Try to identify where a state-change is happened. For each change, fill the table (in the answer sheet) with the change time, the cwnd size at the time of change, the new cwnd size, the new state and the event that caused this change. Provide also the initial state. (Optionally you can give, additional with the table, a brief description, but not more than 3 lines)

Submission

You have to submit:

- Your answers to all the questions. Use the provided **answer sheet** for you answers and graphs. Provide your answers in the appropriate answer field for each question
- The source codes of the two tasks.
- The graphs and the produced data.

Attention: You have to submit **one PDF** file that contains all the answers and graphs; the name of the file should be ***lab4-<lastname_firstletter>.pdf*** *(example: lab1-vanderveldt_k.pdf, or lab1-pittaras_c.pdf)*. Additionally you have to submit one zip (or rar) file containing the source codes, the graphs and the data. The name of the file should be: ***lab4-source-<lastname_firstletter>.zip***

Any other kind of submission will not be taken into account. You must also put your full name and your student number at the top of the answer sheet.