Programming Assignment: Understanding Congestion Control Process in TCP in NS-3

Scenario: You need to simulate a multi-hop network shown in Fig.1. Concretely, the neighbored hosts and routers are all connected with each other through the point-to-point link with 10Mbps bandwidth and 5ms delay. In running, each host contained in the green cloud connect to a server in the blue cloud through a routing path of (R1, R2, R3, R4) through TCP. In addition, the TCP is adopted with a congestion algorithm like newReno, Reno and Vegas. Meanwhile, each host in the purple cloud sends UDP packets to a sink in the gray cloud at different intensities in sending rates via a path (R2, R3). The UDP is used to cause different congestion level of the link between (R2, R3) that can affect the QoS performance of the TCP.

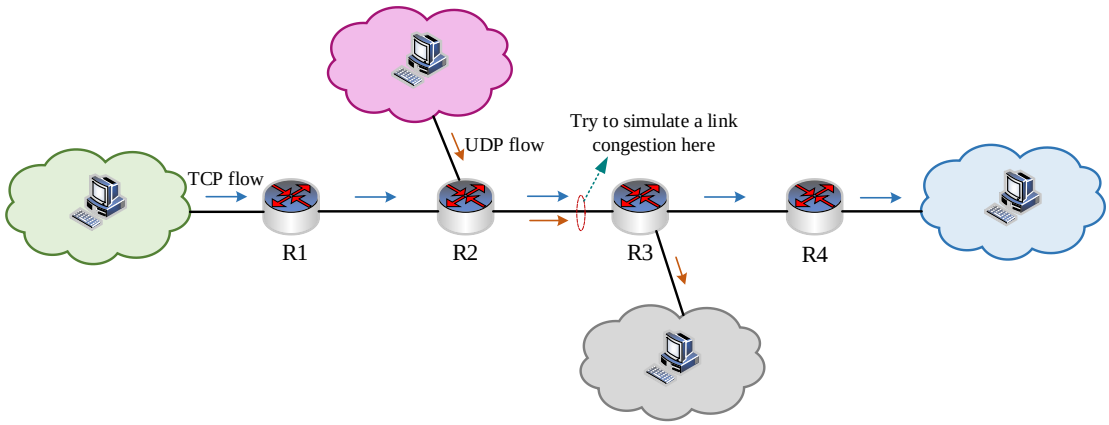

Figure 1: Network topology for experiments

Experiment parameters turning: During experiments, you can adjust the experiment parameters including as follows: a) UDP sending rate; b) TCP sending rate; c) TCP parameters including but not limited to buffer sizes, Nagle algorithm and MTU; and d) the different queuing buffer sizes of routers.

Goals: You need to test the QoS performance including delay and packet loss rate between the host in the green cloud and the server in the blue cloud. Through testing, you are required to achieve following goals:

(a) Learn the dynamics of TCP congestion control process under the experiment situations configured with the aforementioned different parameters.

(b) Learn the limitations of TCP QoS performance and find out what their intrinsic

reasons are that can lead to the deterioration on TCP in experiments.

(c) Learn how to use NS-3 to conduct network experiment researches.

(d) Learn how to make your experiment repeatable for other researchers, which demands you to package your codes for your task submission to me.

Submissions and Deliverables

You are required to write a technical report about your conducted experiments. The report must contain four parts: (a) the statements about your vision / goal about the experiments, e.g. if you want to study the QoS performance of TCP changes under heavily congested links; (b) experiment setup including parameters used; (c) the numerical results in experiments that can be expressed through figures or tables, where you must state your findings in these results in an explicit manner; and (d) the conclusion about your experiments. Note that a simple way to draw a figure is to use Excel or MATLAB.

In addition, you need to submit your final source code. Meanwhile, a README file should be prepared that provides guidance to repeat your experiment. For example, how to run your code? like executing commands through "./waf --run scratch/xxx".

In summary, the submissions involve following parts:

(i) The technical report,

(ii) the source files,

and (iii) the README file.

You need to compress the above submission materials as a file in rar/tar.bz2/tar.gz/zip. Then, you should E-mail the compressed file to zhouby@zhejianglab.com with the E-mail and file titles all in "ATCN-Programs-[your name]-[your student number]", e.g. ATCN-Program-张三-12345 and ATCN-Program-张三-12345.rar. Note that, a violation of such title naming convention will not be considered as your assignment.

Simulation environment setup:

The above experiments require you to install the NS-3 environment under Ubuntu 20.04.

1. Download the Ubuntu 20.04 64bit/32bit ISO file depending on your system from https://ubuntu.com/ (Higher version of Ubuntu is not currently compactable with the existing NS-3).

2. Download VirtualBox from https://www.virtualbox.org/. After the installation of the downloaded VirtualBox, you can install the Ubuntu as VM step-by-step. You can turn on the hardware acceleration option in the VM to ensure efficiency. Besides, you can also directly install the Ubuntu on your own laptop with your Windows system. Please find installation details on your own through searching on Baidu or Bing.

3. Login your Ubuntu system with your user name and password.

4. Download NS-3 v3.35 source tar file from https://www.nsnam.org/releases/ns-3-35/ using a Firefox browser available in Ubuntu

5. Open a shell in Ubuntu and put following commands

```
sudo apt install gcc g++ python3 python tcpdump wireshark-qt
tar xf ns-allinone-3.35.tar.bz2
cd ns-allinone-3.35/ns-3.35
./waf configure
./waf build
```

6. Now, your NS-3 environment has been setup. You can run following command to test your setup.

```
./waf –run scratch/scratch-simulator
```

7. How to write a simulation instance by yourself?

(i) You need to create a .cc source file under the scratch directory. A simple way is to copy the scratch/scratch-simulator.cc file and modifies the file by yourself.

(ii) You can develop the code according to the official documents that can be found in https://www.nsnam.org/releases/ns-3-35/documentation/. You'd better to first start with the tutorial part, and then carefully read manual and model library documentations.

(iii) I recommend you to use an IDE environment for developing the above NS-3 source file. A common option is the Eclipse IDE for C/C++ Developer version under

Linux system which can be obtained as follows.

https://www.eclipse.org/downloads/packages/

In addition, the configuration of Eclipse can be referred from the following webpage:

https://www.nsnam.org/wiki/HOWTO_configure_Eclipse_with_ns-3

Questions:

1. You can discuss the questions relating to the experiment environment in class with your classmates.

2. You can inquire the questions about researches on this document through sending an E-mail to me at zhouby@zhejianglab.com. I will reply to you in my free time.