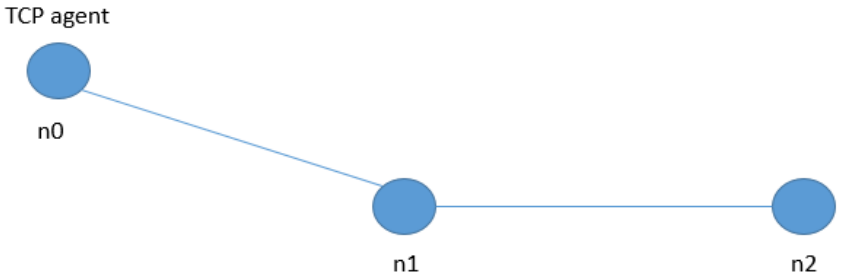
COMPUTER NETWORKS (CS F303)
LAB-SHEET – 8
TOPIC: Transport Layer Protocol Simulation using NS2

Learning Objectives:

1. **To understand the functioning of Transport Layer protocols (i.e., TCP and UDP)**
2. **To understand the working of congestion control algorithm of TCP**
3. **To understand the fairness functionality of TCP**

Prerequisites: Lab-6 and lectures on TCP

Exercise 1: (Motivation: How a new TCP connection starts and progress as per AIMD algorithm.)
Create the following topology using ns2:

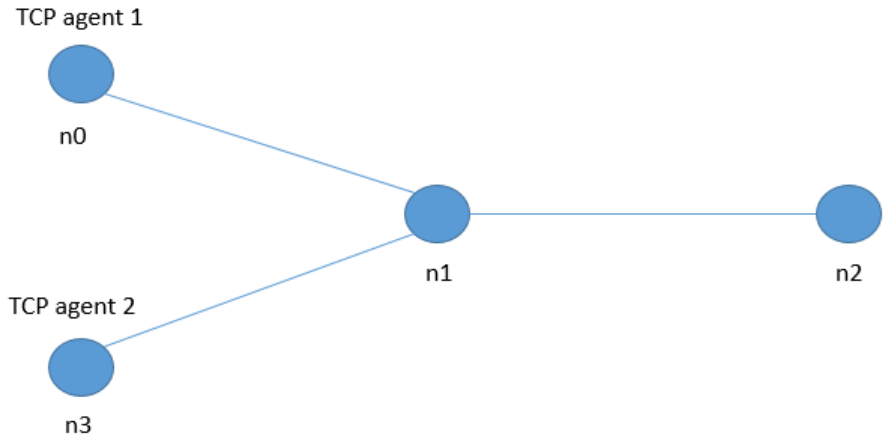


Node n0 is the source of TCP traffic, and n2 is the receiver/sink. Both links are full-duplex, 2Mbps with 100ms delay.
In your simulation, start the TCP traffic at 1 second and run it till 30 seconds. End the simulation.
Tasks:

1. Using Xgraph, plot the throughput of the TCP flow w.r.t. time.
2. In every TCP-type class, the congestion window size of the TCP module is available in the variable ***cwnd_***. Use the congestion window above and plot the variation of congestion window w.r.t time(Hint: you will have to obtain the value of **cwnd_** *repeatedly*)

Exercise 2: (Motivation: To understand fairness property of TCP in the presence of other TCP flows with same RTT values.)

Extend the topology used in Exercise 1 as shown below.



We have added another node n3 which generates TCP traffic. The receiver/sink for this traffic is also n2. All links are full-duplex, 2Mbps with 100ms delay.
In your simulation, start both the TCP agents at the same time at 1 seconds. Run them for 30 seconds, and end the simulation.

Tasks:

1. Plot the graphs of throughput w.r.t. time and congestion window (as done previously).
2. Modify the simulation scenario: Star the TCP agent at n0 at 1 seconds, while the TCP agent at n3 at 10 seconds. Plot the graphs for throughput and congestion window. Compare both flows behavior and state your observations? (Discuss with the instructor in the lab!!!)

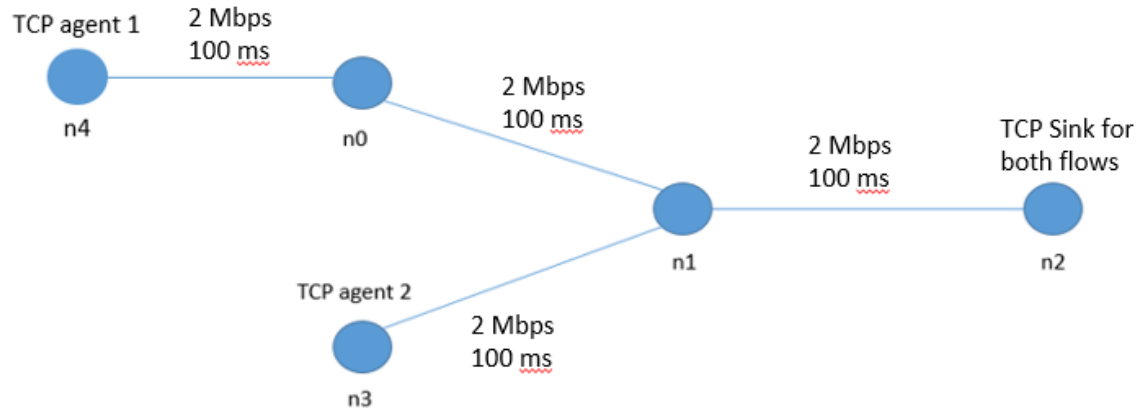
In order to effectively observe your simulation in ***nam***, you may assign different colors to the two TCP flows. A small code snippet for it is given below:

```
//add the following two lines after "set ns [new Simulator]"
$ns color 1 Red
$ns color 2 Blue
# After you create a TCP agent and attach it to node n0…
set tcp0 [new Agent/TCP]
$ns attach-agent $n0 $tcp0
//…add the following line
$tcp0 set fid_ 1
//Repeat this procedure for the second TCP agent and assign it fid 2
```

Exercise 2.1: (Motivation: To understand the fairness property of TCP in the presence of other TCP flows with different RTT values.)

Consider two TCP flows, first between node n4 and n2 and second between n3 and n2 as shown in the following topology. Assume all links are of same bandwidth i.e. 2Mbps with 100 ms propagation delay. Therefore, RTT of first flow becomes 300 ms. (with no congestion) and for second flow it is 200 ms. As you can see that these two flows are sharing a common link (i.e. n1----n2). Hence throughput of the flows is governed by this shared link (aka bottleneck link). The aim of this exercise is to examine RTT fairness of TCP flows having different RTT values.

Modify the TCL script that have been used by you for Exercise 2 by incorporating necessary changes as per current scenario.

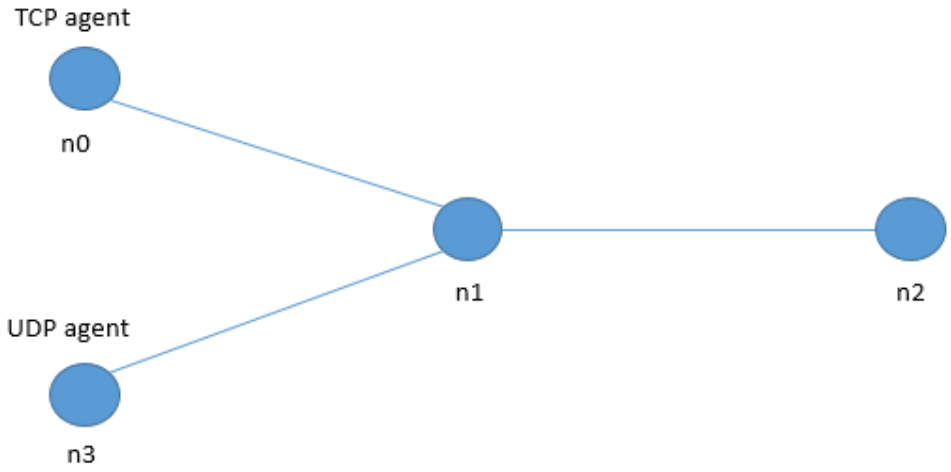


Tasks:

1. Repeat the tasks of Exercise 2 for the topology shown below.

Exercise 3: (Motivation: To understand TCP flow fairness with UDP flow.)

Now, replace TCP flow at node n3 with a UDP traffic agent which generates CBR traffic with packet size of 800 bytes and rate of 0.005 (i.e., 200 packets/sec or 1.28 Mbps).



Tasks:

1. Plot throughput w.r.t. time for TCP as well as UDP flows.
2. Add code in your script to calculate the average throughput of the TCP flow. (Note: can you guess what the average throughput of UDP flow is???)
3. Is total throughput (sum of both flows throughput) equals to the bandwidth of bottleneck link (i.e., n1---n2)? YES/NO. (Hint: Answer should be NO. The tasks 4, 5 and 6 will help you to understand the reasoning behind this.)
4. Plot the variation of congestion window for the TCP flow.

5. How does the presence of a UDP flow on a bottleneck link (i.e., n1---n2) impact the throughput and congestion window size of the TCP flow?
6. Calculate the packet loss count for both the flows. Which flows packet losses are more? TCP or UDP?

Take Home Exercise:

The default TCP agent in ns2 (specified as **Agent/TCP** in your code) is **TCP Tahoe** implementation. Repeat all the above exercises by replacing it with a TCP Reno agent (using **Agent/TCP/Reno** in your code).

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