CS342, Assignment 4

Network Simulation Using ns-3

Group 65

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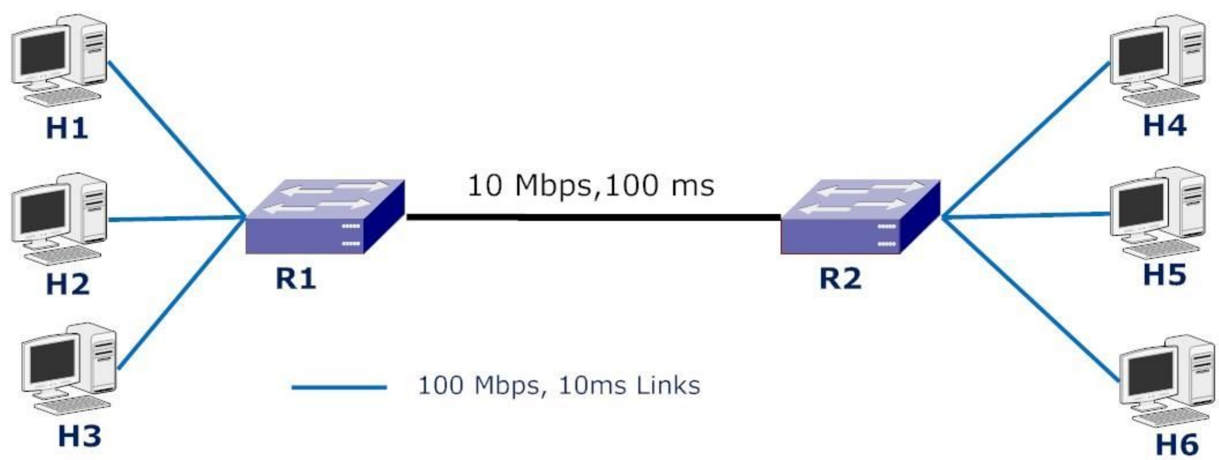
Application-4

Compare the effect of buffer size on TCP and UDP flows. Select a Dumbbell topology with two routers R1 and R2 connected by a (10 Mbps, 100 ms) link. Each of the routers is connected to 3 hosts, i.e. H1, H2, H3 are connected to R1, and H4, H5, H6 are connected to R2. All the hosts are attached to the routers with (100 Mbps, 10 ms) links. Both the routers (i.e. R1 and R2) use drop-tail queues with equal queue size set according to bandwidth delay product. Choose a packet size of 1.5 KB. Start 4 TCP New Reno flows, and after a while start 2 CBR over UDP flows each with 20 Mbps. These flows are randomly distributed across H1, H2 and H3. Increase the rate of one UDP flow up to 100 Mbps and observe its impact on the throughput of the TCP flows and the other UDP flow. Vary the buffer size in the range of 10 packets to 800 packets and repeat the above experiments to find out the impact of buffer size on the fair share of bandwidth and plot the necessary graphs. Make appropriate assumptions wherever necessary.

Network Topology-:



Main features of the above configuration -:

- **Dumbbell topology** with two routers R1 and R2 connected by a **(10Mbps, 100ms)** link.
- All the hosts are attached to the routers with **(100 Mbps, 10 ms)** links.
- Both the routers use drop-tail queues with equal queue size set according to the bandwidth-delay product.
- Packet Size - **1.5 KB** (1500 Bytes)

Tasks to do:

Start 4 TCP New Reno flows, and then start 2 CBR over UDP flows each with 20 Mbps.

1. Vary the buffer size in the range of 10 packets to 800 packets and repeat the above experiments to find out the impact of buffer size on the fair share of bandwidth and plot the necessary graphs.
2. Increase the rate of one UDP flow up to 100 Mbps and observe its impact on the throughput of the TCP flows and the other UDP flow.

The CBR service category is used for connections that transport traffic at a constant bit rate.

We have created four TCP connections and two UDP connections.

The default configuration for TCP connections is set as TCP New Reno.

Details of the TCP connections:

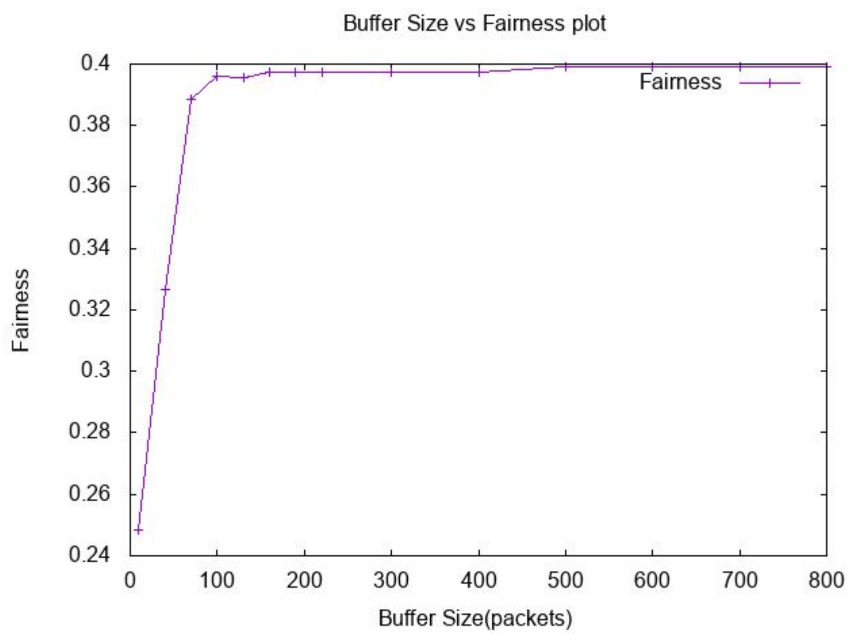
1) Host 2 to Host 5
2) Host 2 to Host 6
3) Host 4 to Host 6
4) Host 4 to Host 2

Details of CBR over UDP Flows-:

5) Host 4 to Host 3
6) Host 1 to Host 3

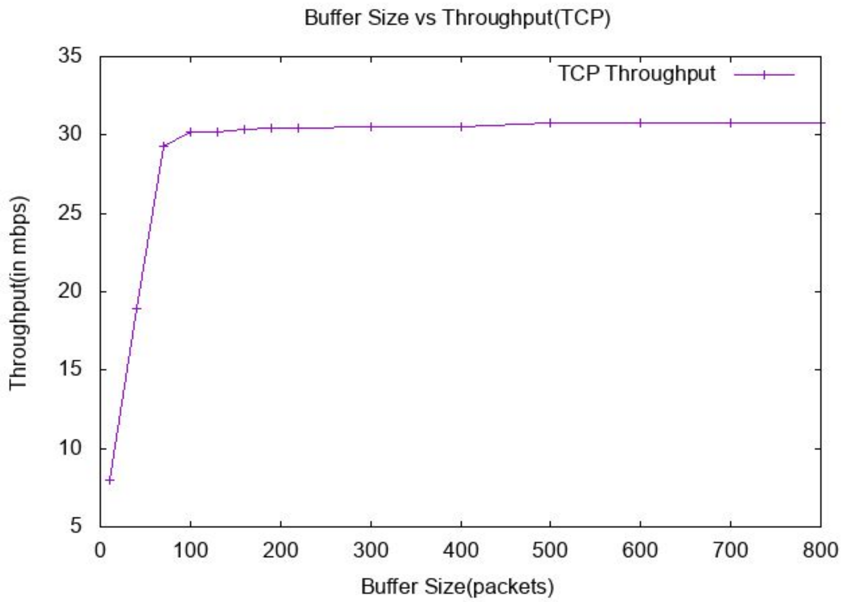
Task 1:

Increased Socket Buffer Size from 10 Packets to 800 Packets The buffer size is increased from 10 to 100 packets with an interval of 30 packets and after 220 packets, the interval size is increased to 80 packets for once and thereafter, after 300 packets, the interval size is 100 packets.



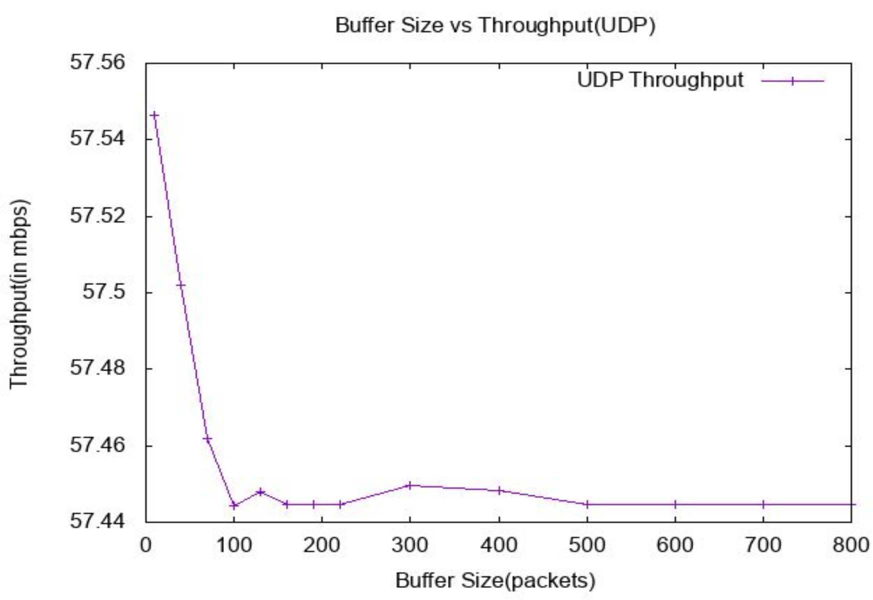
Observation:

From the above graph, it can be observed that **as we increase the buffer size, the fairness index increases significantly.** The increase in the fairness index indicates that the share of bandwidth among the 6 connections is increasingly fair. A fairness index value of 1 denotes that bandwidth is shared equally among all participating connections. The **value saturates after a point** (when the buffer size becomes approximately 200 packets, the value becomes approximately 0.4) and increasing the buffer size after this point has no effect on the fairness index value. This is **because the throughput of each connection is limited by the link bandwidth** and thus it can’t be increased beyond a certain saturation point.



Observation:

We can observe the effect of increasing the buffer size on the total throughput of the TCP connections (Connections 1,2,3 and 4 are TCP connections). We can observe that **as the buffer size increases, the TCP throughput increases, until it reaches saturation level** (approximately 31 Mbps). When the buffer size is less, throughput is less as there are many candidates for the queue buffer in the router at bottleneck link. Due to queue overflow, a large number of packets experience delay or are even dropped during congestion. Congestion results in decrease of the throughput and a very high packet loss rate. This is the reason why throughput and efficiency of TCP increase with increase in buffer size because large buffer size reduces the packet congestion thereby reducing the delays.

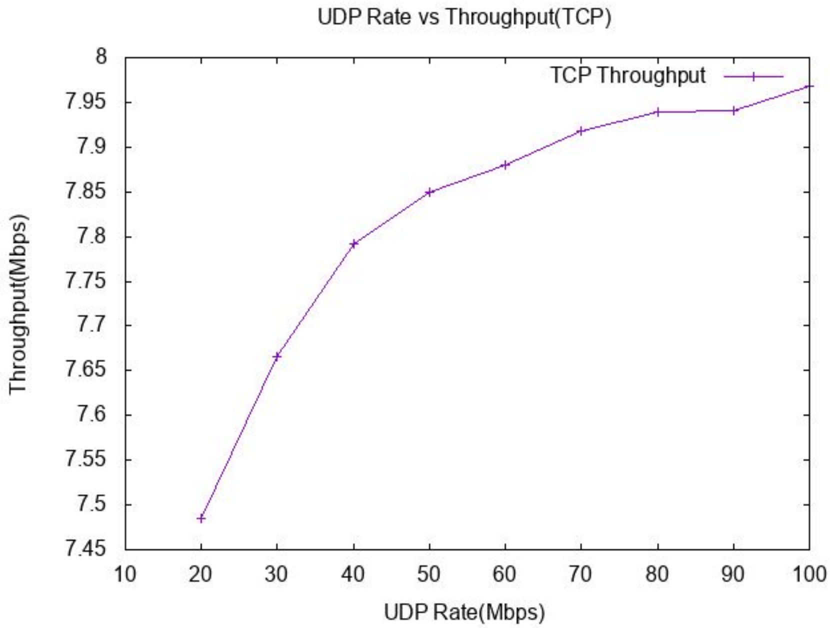


Observation:

We can see the effect of increasing buffer size on the total throughput of the UDP connections (Connection 5 and 6) from the above graph. It can be easily observed that **the UDP throughput decreases as the buffer size is increased, and remains constant after the buffer size of 300 packets is reached** after which increase in buffer size has no effect on the UDP throughput. The decrease is not very substantial. This is because **when the buffer size increases, the fairness index value increases and therefore, TCP connections also compete for throughput with fair share** thereby decreasing the high throughput of the UDP connections.

TASK 2:

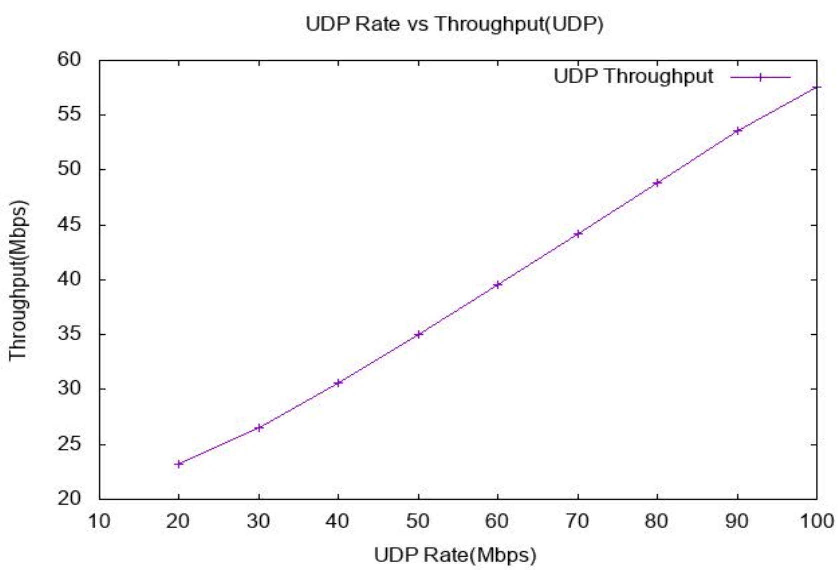
Initially all the connections have a data rate of 20 Mbps each. Starting from 1 second, data rate of Flow number 6 (UDP) is increased from 20 Mbps to 100 Mbps linearly with time (with an interval of 1 second each) in steps of 10 Mbps keeping buffer size constant at 10*packetSize.



Observation:

We can see the effect of increasing UDP rate of Flow number 6 on the throughput of the TCP connections from the above graph (Total Throughput of Connection 1, 2 and 3 and 4).

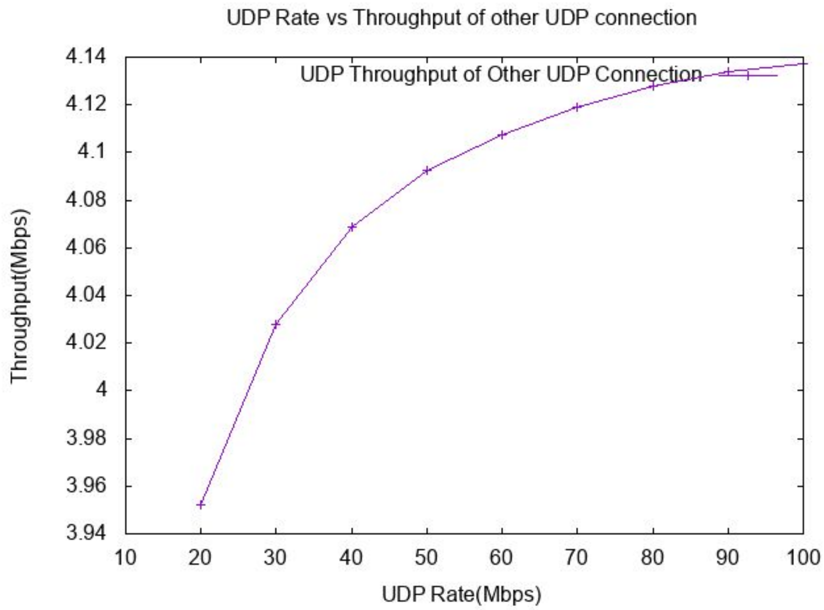
As the UDP rate of connection 6 is increased linearly with time (in steps of 10), the **rate of increase of TCP throughput decreases**, until it starts to approach a constant value (~7.97 Mbps). **This is because the shared link is getting more and more occupied by the UDP connection as we are increasing the UDP rate.**



Observation:

We can see the effect of increasing UDP rate of Flow number 6 on the throughput of the UDP connections (Total Throughput of Connection 5 and 6) from the graph plotted above.

We can easily see that **as the UDP rate of flow number 6 increases linearly with time, the overall UDP throughput also increases (almost linearly).** The simple reason behind this observation is that **when the UDP rate is increased, more UDP packets are released per unit time.**



Observation:

This graph depicts the UDP throughput from the other UDP connection (Connection No. 5) as a function of the UDP rate of Flow number 6. As with the TCP throughput shown in graph no. 4, **the rate of increase of UDP throughput from the other connection decreases as the flow rate of connection 6 is increased.** This is **because the shared link is getting more and more occupied by the 6th UDP connection with its increasing UDP rate.**