Assignment-4

Application-4
Network Simulation using ns3
Group 4

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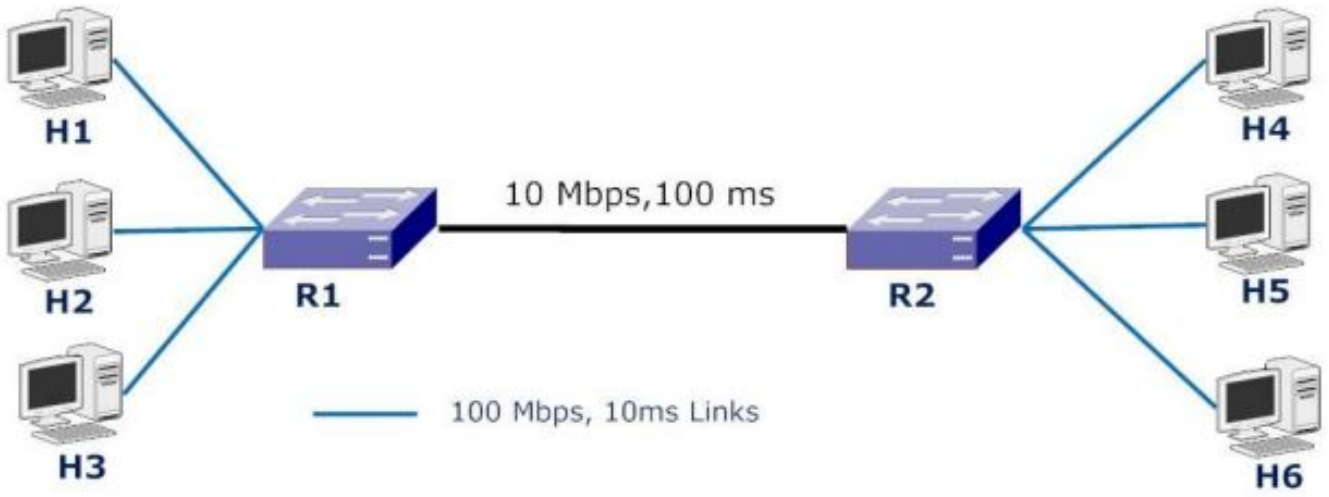
NETWORK CONFIGURATION



Dumbbell topology with two routers R1 and R2 connected by a (10 Mbps, 100 ms) link.

- 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 (i.e. R1 and R2) use drop-tail queues with equal queue size set according to bandwidth-delay product.
- Packet Size - 1.5 KB

Created six connections(3 TCP, 3 UDP) randomly distributed across the hosts

TCP New Reno Flows

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

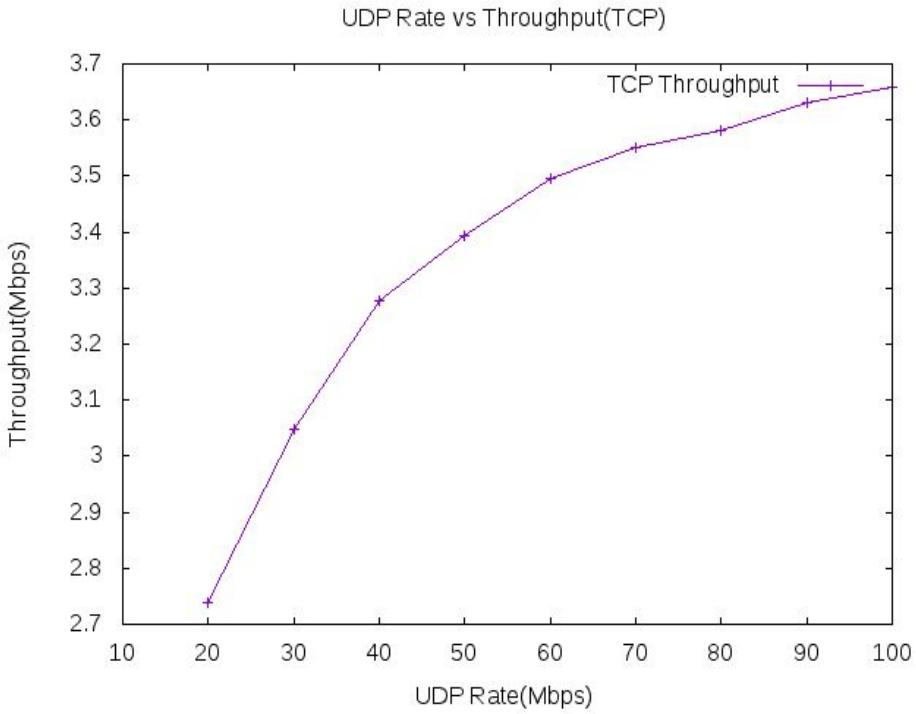
CBR over UDP Flows

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

PART-1

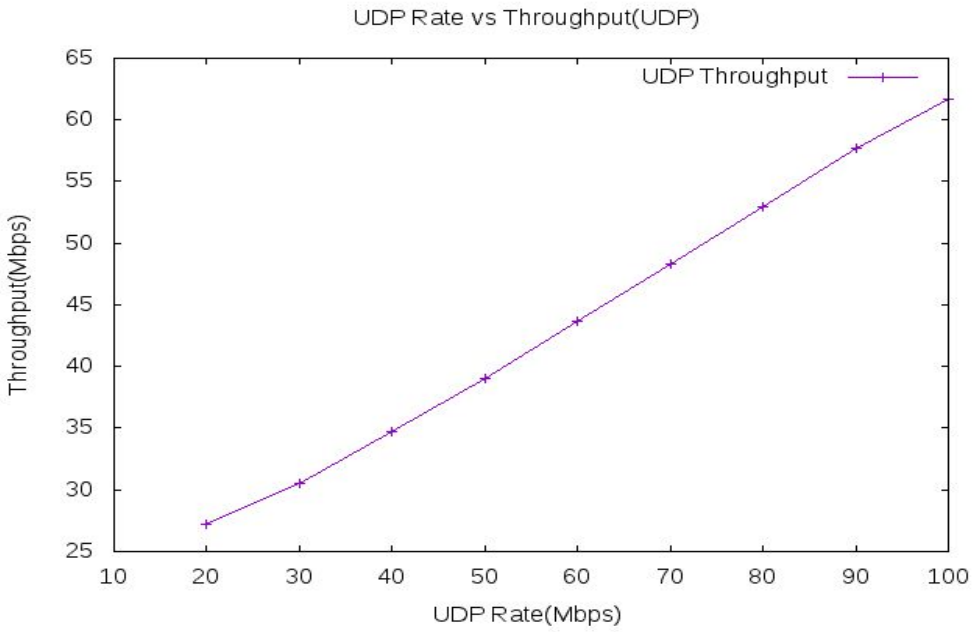
Initially all the connections have a data rate of 20 Mbps each. Data rate of Flow number 6(UDP) is increased from 20 Mbps to 100 Mbps linearly with time in steps of 10 Mbps keeping buffer size constant at 10*packetsize and plotting graphs.

TIME(seconds)	UDP RATE(Mbps)
1	20
2	30
3	40
4	50
5	60
6	70
7	80
8	90
9	100
10	End



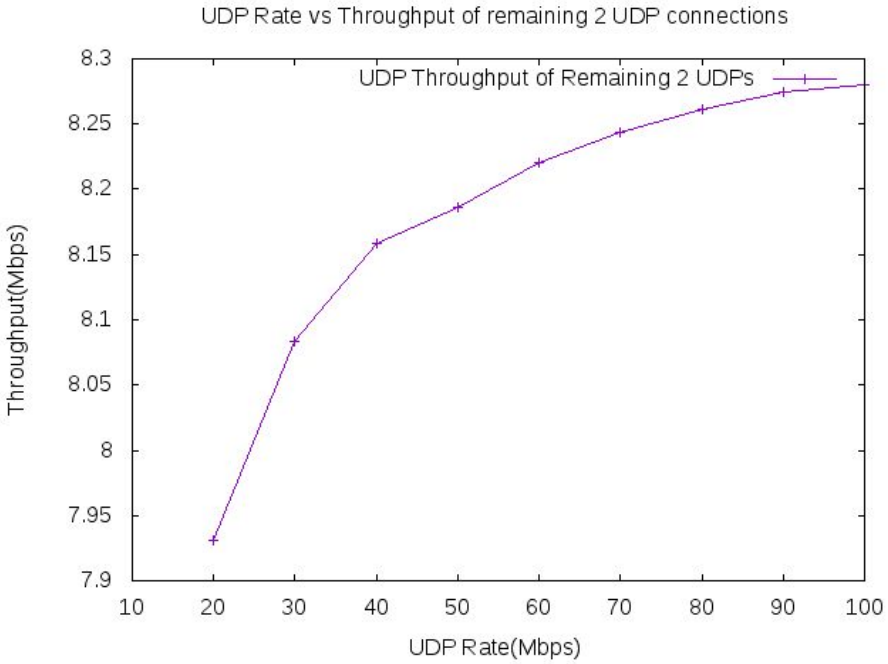
Observation:

The above graph illustrates the effect of increasing UDP rate of Flow number 6 on the throughput of the TCP connections.(Total Throughput of Connection 1, 2 and 3) As the UDP rate is increased linearly with time, the rate of increase of TCP throughput decreases,until it starts to approach a constant value(~3.7 Mbps) since the shared link is getting more and more occupied by the UDP connection with increasing UDP rate.



Observation:

The above graph illustrates the effect of increasing UDP rate of Flow number 6 on the throughput of the UDP connections.(Total Throughput of Connection 4, 5 and 6)
As the UDP rate of flow number 6 increases linearly with time, the overall UDP throughput(calculated for all the three UDP connections) also increases as more UDP packets are released per unit time.

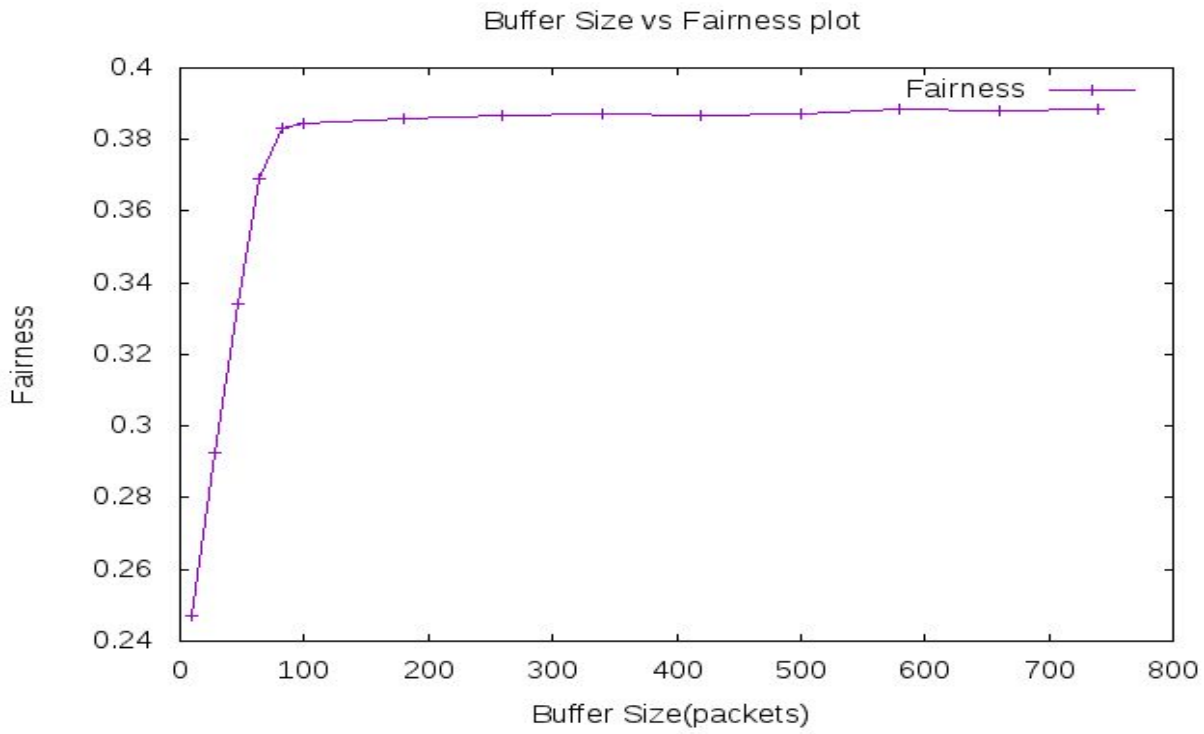


Observation:

This graph depicts the UDP throughput from the other two connections(Number 4 and Number 5) as a function of the UDP rate of Flow number 6.
We can observe that as with the TCP throughput, the rate of increase of UDP throughput from other two connections decreases as Flow rate of 6 is increased as the shared link is getting more and more occupied by the 6th UDP connection with its increasing UDP rate.

PART 2

Increased Socket Buffer Size from 10 Packets to 800 Packets The buffer size is increased from 10 to 100 packets with an interval of 18 packets and after 100 packets, it is increased till 800 packets at an interval of 80 packets.



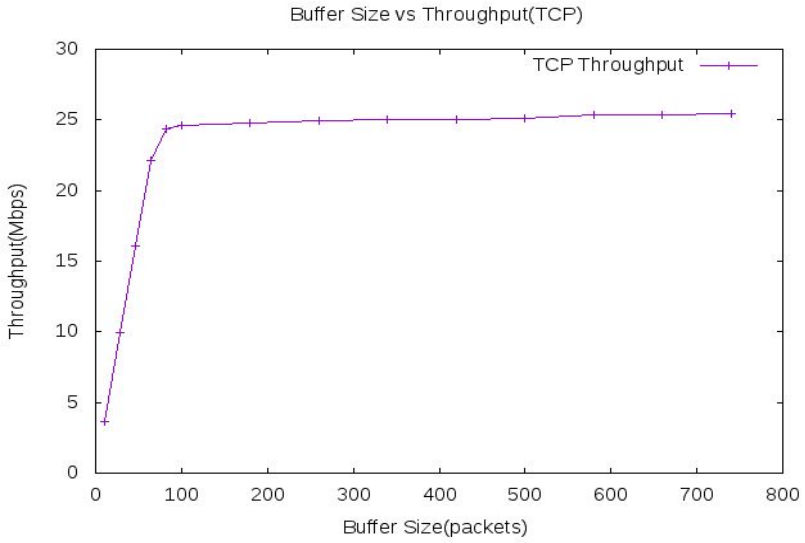
$$\text{Fairness Index} = \left(\sum_{1}^{6} Tput\right)^2 \div 6 * \sum_{1}^{6} Tput^2$$

Observation:

We observe that as buffer size increases, the fairness index increases, which indicates that the bandwidth share among the 6 connections is increasingly fair.

A fairness index value of 1 indicates that bandwidth is shared equally among all participating connections. The value saturates after a point, and increasing the buffer size has no effect thereafter.

This is because the throughput of each connection is limited by the link bandwidth and thus it can't increase further.



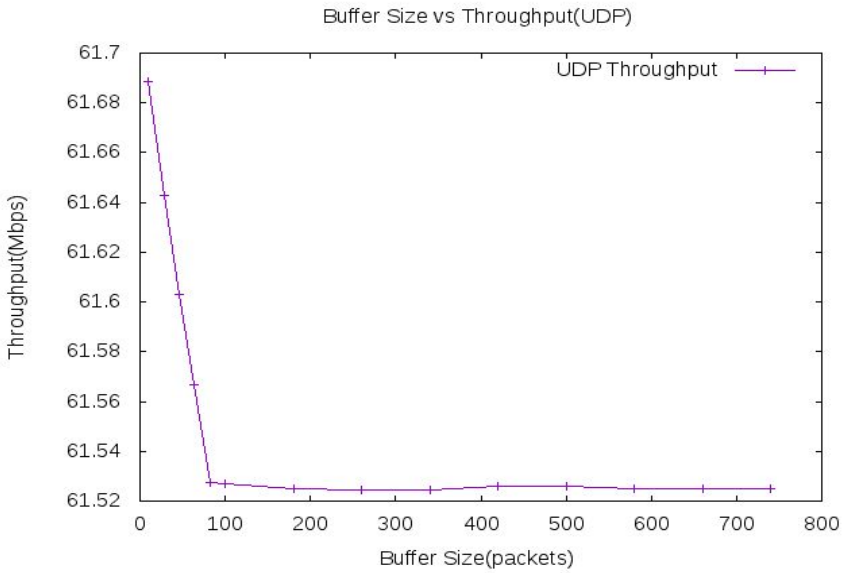
Observation:

The above graph illustrates the effect of increasing buffer size on the throughput of the TCP connections.(Total Throughput of Connection 1, 2 and 3)

From the above graph we can observe that as the buffer size increases, TCP throughput increases, until it saturates.

When buffer size is less, throughput is low as there are too many packets contending for the queue buffer in the router at bottleneck link.

During congestion, a large amount of packets experience delay or even be dropped due to the queue overflow. Severe congestion problems result in degradation of the throughput and large packet loss rate. Hence, throughput and efficiency of TCP increases with increase in buffer size.



Observation:

The above graph illustrates the effect of increasing buffer size on the throughput of the UDP connections.(Total Throughput of Connection 4, 5 and 6)

As can be observed from the above graph, UDP throughput decreases as the buffer size is increased, and remains constant after the buffer size of 100 packets is reached after which increase in buffer size has no effect on the UDP throughput.