Assignment-4 Report

Application-4
Group-67

Group Members:

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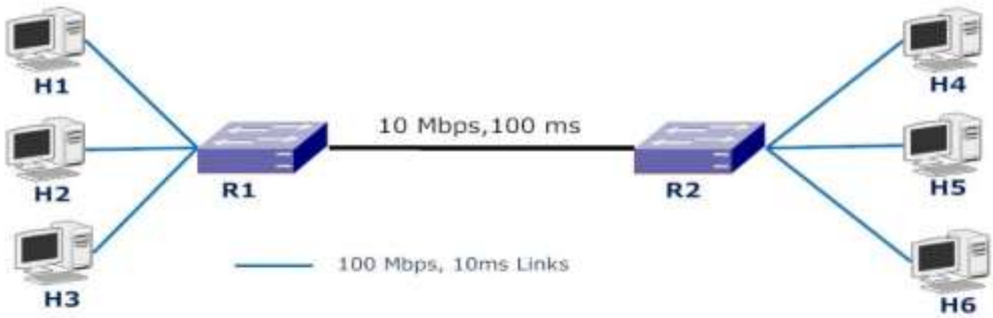
Network Configuration



- Two routers R1 and R2 connected via (10 Mbps, 100ms) link
- Three hosts connected to each router via a (100 Mbps, 10 ms) link
- R1 and R2 use drop-tail queues with equal queue size set according to bandwidth delay product
- The packet size is taken to be 1.5 KB

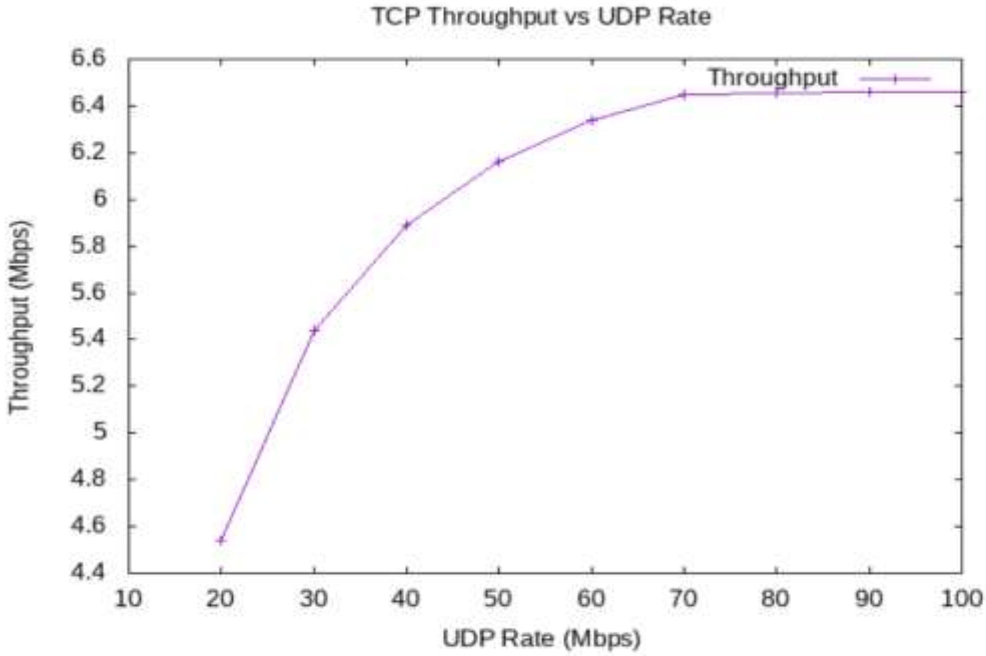
As per given assignment, we create 6 Connections (4 TCP, 2 UDP) so that these connections cover all the possible given hosts to us.

TCP Reno-Flows :
(1) H2 to H1
(2) H3 to H6
(3) H4 to H6
(4) H5 to H2

CBR over UDP Flows:
(1) H3 to H4
(2) H3 to H1

FIRST PART:
All the given connections have an initial rate of 20 Mbps. Rate of second UDP-flow is increased from 20 Mbps to 100 Mbps in steps of 10, keeping the buffer size constant. For this variation, the TCP throughput is measured and its graph is plotted. The graph comes out as follows:

GRAPH OF OVERALL TCP THROUGHPUT WITH UDP-2 RATE

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Initially, TCP throughput increases very rapidly. However with
increasing UDP rate, the shared links get more occupied by UDP flow
thereby leading to the reduction in the rate at which TCP throughput was
changing. Hence as we change the UDP rate linearly from 20 Mbps to 100
Mbps, the rate of TCP throughput increment decreases. Further, after
reaching a  peak value, TCP throughput is found to saturate and (may)
decrease a bit because of the increasing interference of UDP connection
flow in the links.
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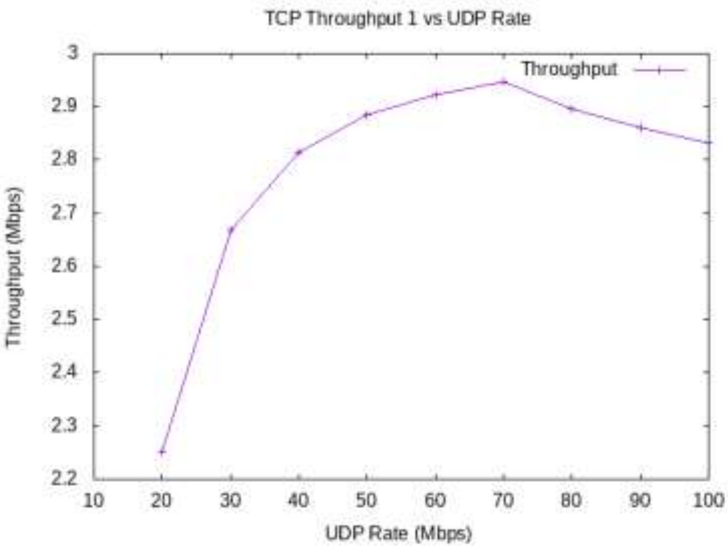
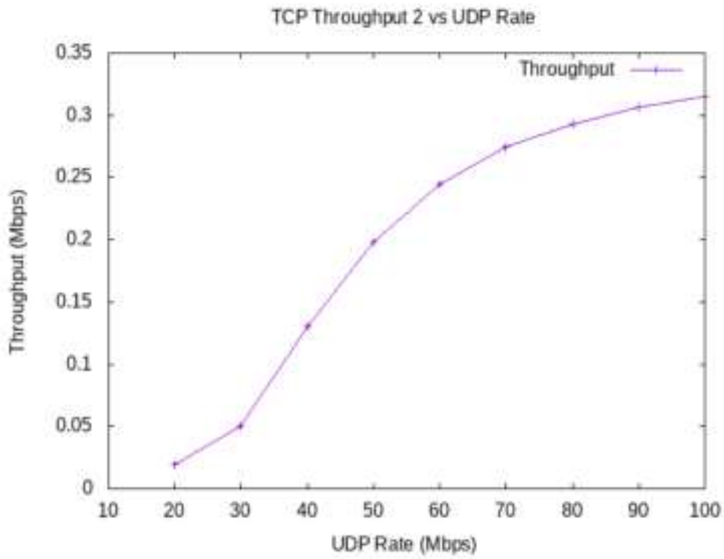
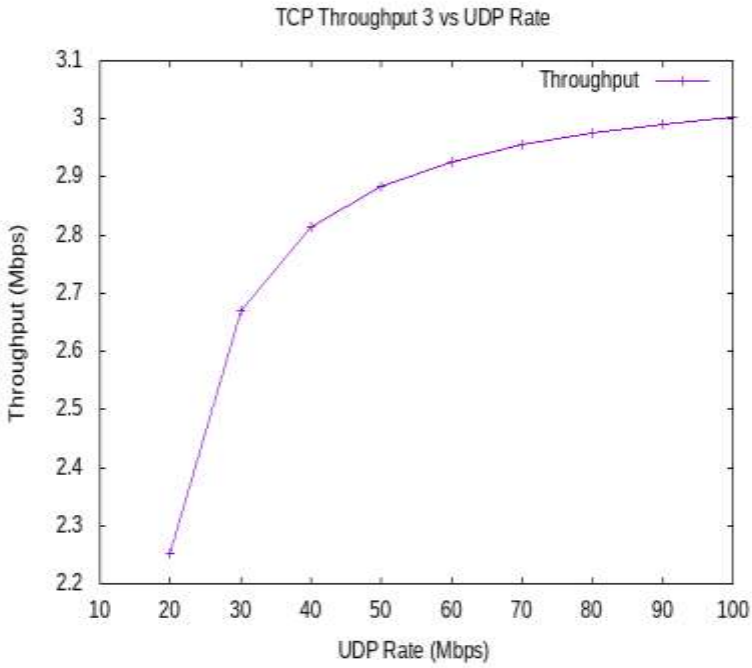
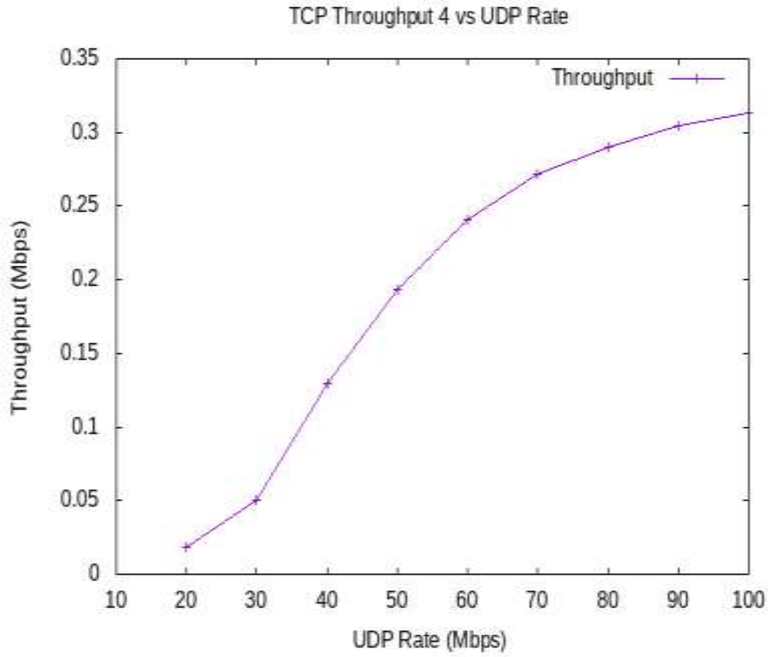
A similar nature is obtained for the variation of the individual TCP connection throughputs with UDP-2 rate. The required 4 curves are as follows:

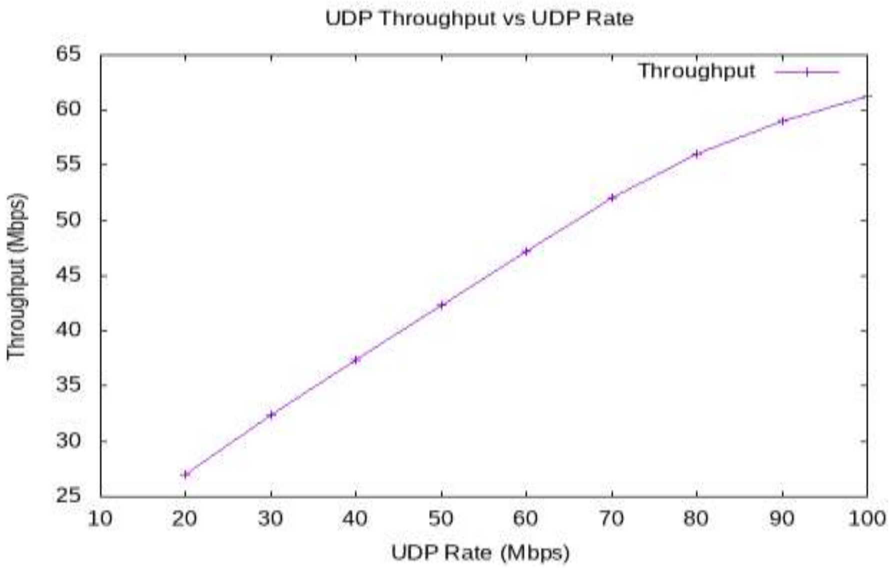






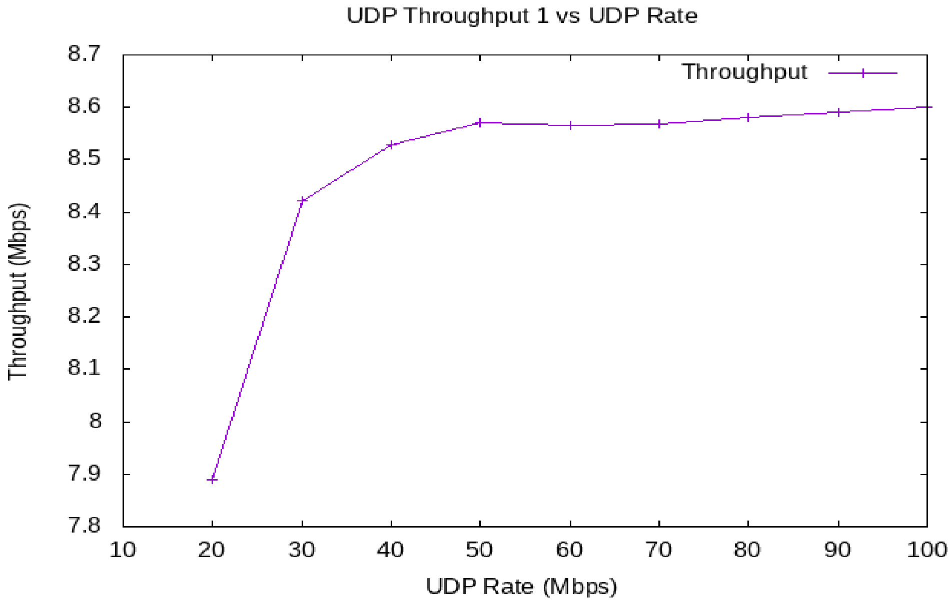


VARIATION OF OVERALL UDP THROUGHPUT WITH UDP-2 RATE



The above graph depicts the plot of overall UDP throughput change with increasing UDP rate of the second UDP flow. The overall UDP throughput is a measure of both the UDP connections taken combined, and hence if we linearly increase the rate of one of the UDP flows it is going to have a direct proportional impact on the overall UDP throughput as well. This is because more UDP packets are propagated per unit time.

VARIATION OF UDP-1 THROUGHPUT WITH UDP-2 RATE

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The above graph is a plot of how throughput of the first UDP connection
changes with increasing rate of second UDP connection. We can see that
the rate of increment of UDP Connection-1 Throughput decreases, as the
shared links are getting occupied more and more by the UDP packets of
the second UDP Connection. Hence even though the throughput of a first
UDP connection is increasing, its rate of increment is still decreasing
because of the above factor.
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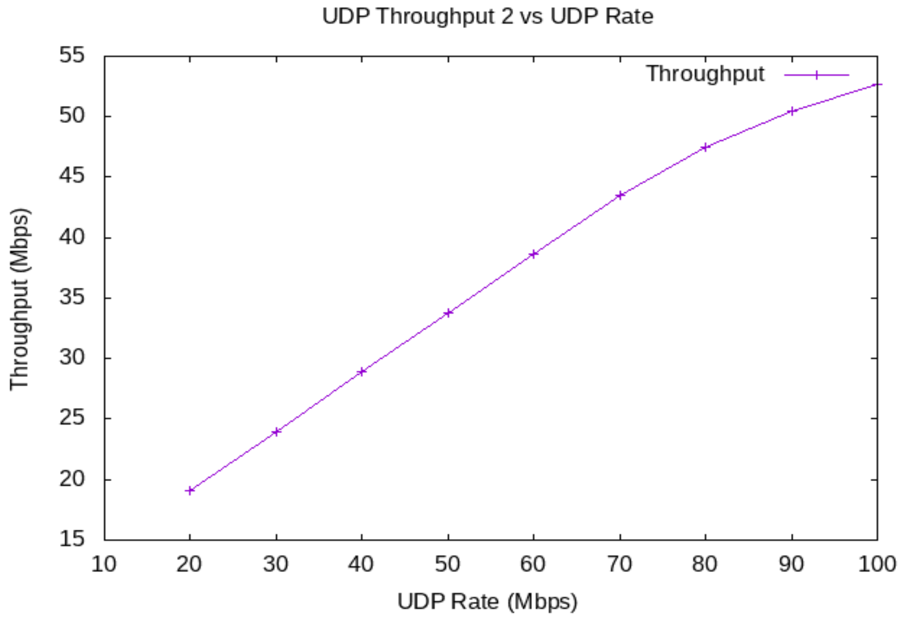
VARIATION OF UDP-2 THROUGHPUT WITH UDP-2 RATE



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There is a linear correlation between UDP Connection-2 Throughput and UDP
Connection-2 Rate. This is because if we increase the UDP rate for a
particular connection, more number of UDP packets from that particular
connection will propagate which will have a direct impact on the throughput
of that particular connection. The graph obtained above is very intuitive.
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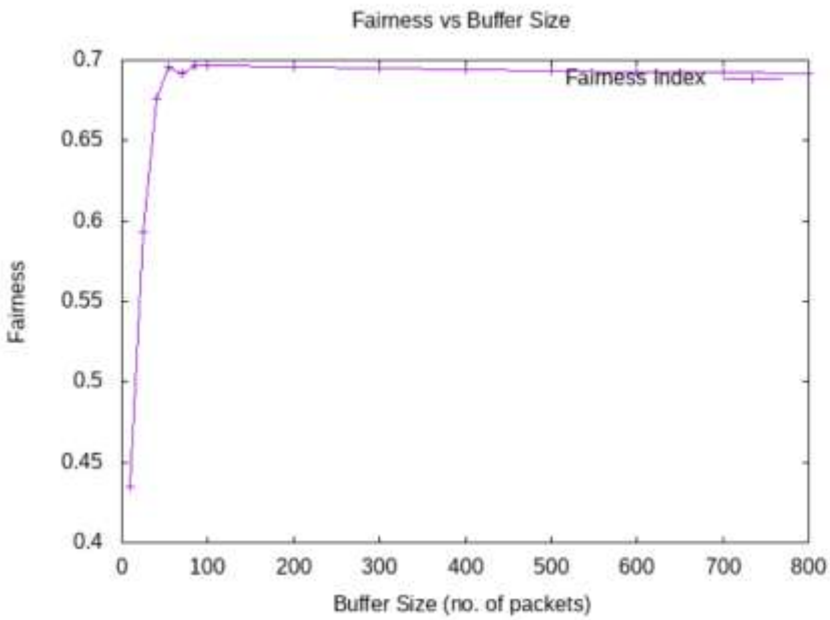
SECOND PART

In the second half of this assignment, we vary the buffer size. Initially buffer size is varied linearly from 10 packets to 100 packets at intervals of 15 packets. From 100 packets onwards, the interval of linear variation changes to 100 packets. In this way, we further increase the size from 100 packets till 800 packets.

VARIATION OF FAIRNESS INDEX VS BUFFER SIZE



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

Fairness index is a measure of how equally is the overall bandwidth distributed across all 6 connections.

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On increasing the buffer size, the fairness index increases. The share of
bandwidth therefore, can be concluded to be increasingly fair with increa
in buffer size. Note that in an ideal case, an index of 1 symbolises that
all connections have equal distribution in overall bandwidth. We have to
note that the throughput of each connection is upper bound by its
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corresponding link bandwidth. Hence, the fairness index is expected to
saturate to a value after some time of increment of buffer size. The
same is seen in the above curve. Beyond the saturation point, increment
in buffer size has no effect on the fairness index.
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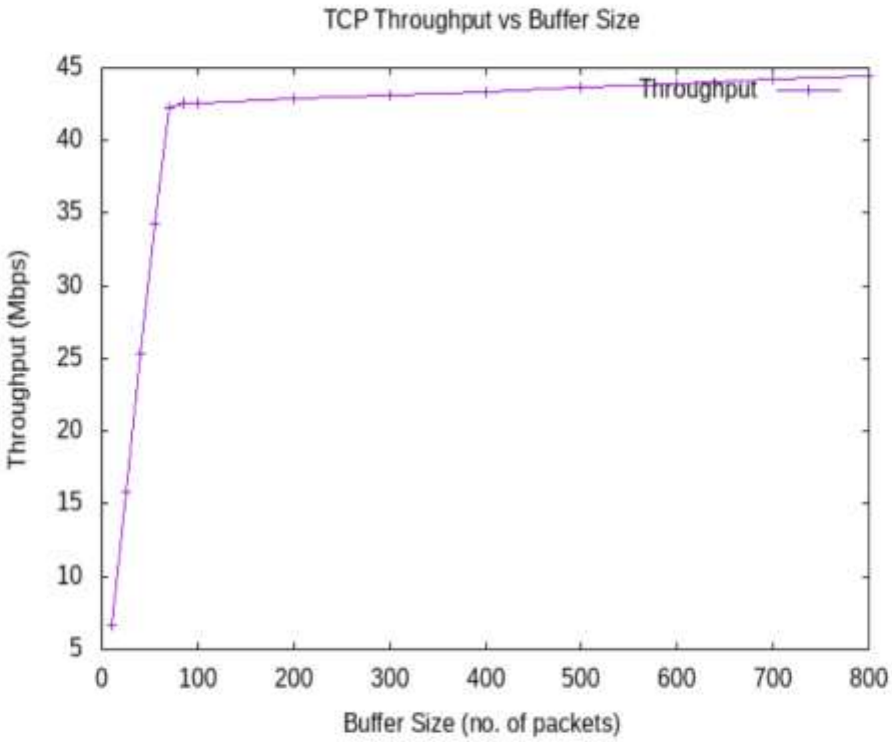
VARIATION OF TCP THROUGHPUT WITH BUFFER SIZE

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Above graph illustrates the variation of combined TCP throughput (of
Connections 1,2,3,4) with increasing buffer size. The variation is
increment and then saturation. When buffer size is low, too many packets
compete for the waiting queue. This congestion may lead to many packets
being dropped and also experiencing unnecessary delays. When queueing
buffer size is increased, the link congestion decreases and therefore
throughput is bound to increase (because of lower packet loss rate and
less queuing delay). The saturation occurs because of the upper bound of
link bandwidth. The variation above doesn't see any major external
interference because TCP has a link-congestion mechanism and is a
connection-oriented protocol.
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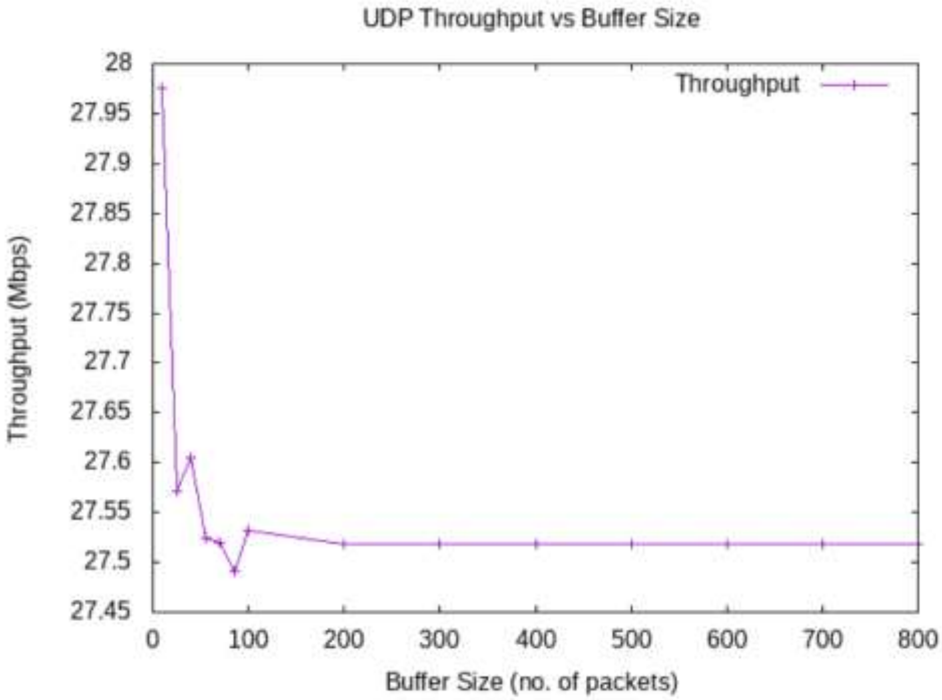
VARIATION OF UDP THROUGHPUT WITH BUFFER SIZE

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With increasing buffer size, the UDP flow throughput (UDP1 + UDP2) is
found to decrease as a general trend. After some decrement, it is also
found to reach a saturation level beyond which the change in buffer size
has no impact on the UDP-throughput. This behaviour can be attributed to
the connectionless nature of UDP and absence of congestion control
mechanisms unlike TCP. Since the TCP throughput is increasing with
increase in buffer size, network traffic will increase which will also
be a factor in decrease of rate initially in case of UDP.
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