CS588:Computer System Lab

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Assignment-3 : Network Simulation using NS-3

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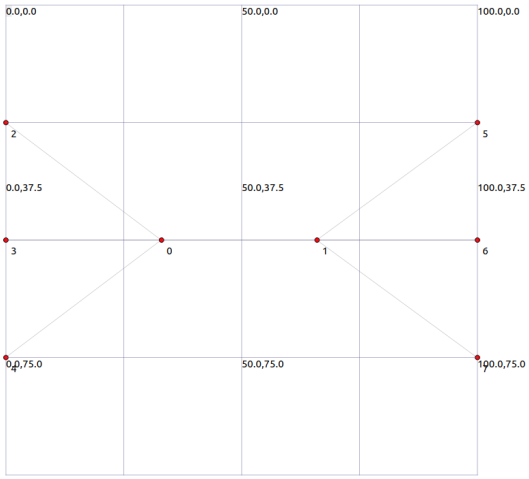
Overview of code :

The bottleneck link and access links are created using the PointToPointHelper class available in ns3. The attributes to the **PointToPointHelper** is set as follows :
For access link
data rate = 100 Mbps
delay = 20ms
For bottleneck link
data rate = 10 Mbps
delay = 50ms

The bandwidth delay product of the bottleneck link is found to be approximately equal to 49 packets.
Therefore, the queue size is set as 49.
The IP and TCP stacks are installed in the net devices using the InternetStackHelper class.
We are installing **TCP Hybla** in
sender 1, **Westwood+** in 2 and **yeaH** in 3.



Topology

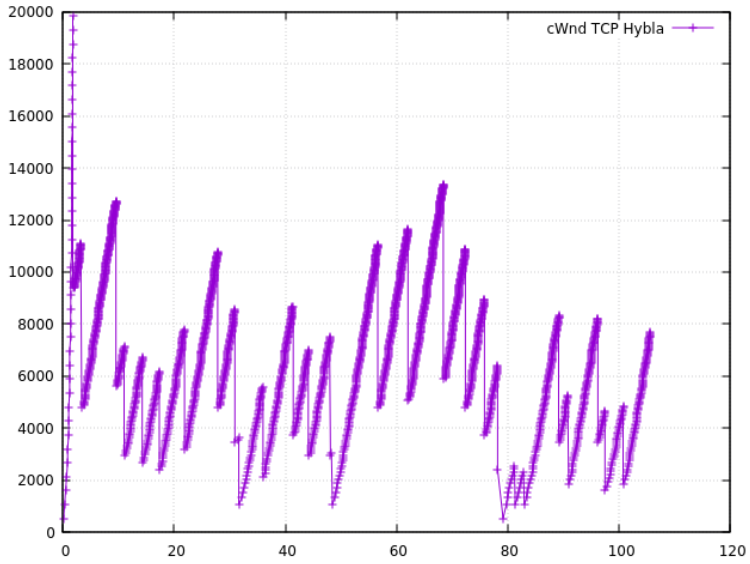
A class called ClientApp is created and installed in sending net devices(Nodes).Sink Application of ns3 is installed @ the receiving end.
Three flows are created namely :
Flow 1 : 2-0-1-5
Flow 2 : 3-0-1-6
Flow 3 : 4-0-1-7

Q1) Start only one flow and analyze the throughput over sufficiently long duration. Mention how you select the duration. Plot the evolution of congestion window w.r.t. time. Perform this experiment with all the flows attached to all the three sending agents.

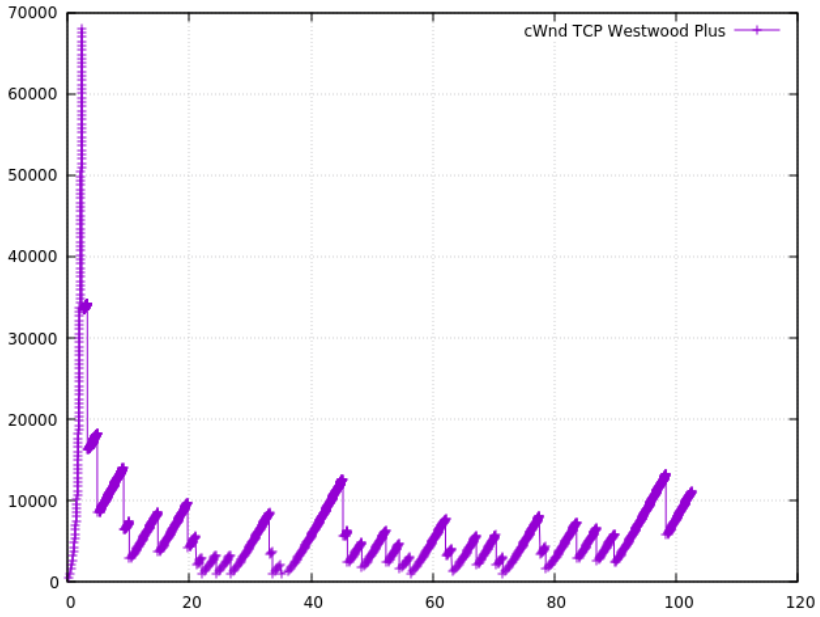
The duration was chosen in such a way that the pattern observed in the congestion window has stabilized. The flow statistics observed using ns3 flow monitor are given below.

```
TcpReno Flow 1 (10.1.0.1 -> 10.2.0.1)
Net Packet Lost: 33
Packet Lost due to Congestion: 33
Max throughput: 367.975
TcpWestwood Flow 3 (10.1.1.1 -> 10.2.1.1)
Net Packet Lost: 35
Packet Lost due to Congestion: 35
Max throughput: 896.848
TcpFack Flow 5 (10.1.2.1 -> 10.2.2.1)
Net Packet Lost: 27
Packet Lost due to Congestion: 27
Max throughput: 575.257
```

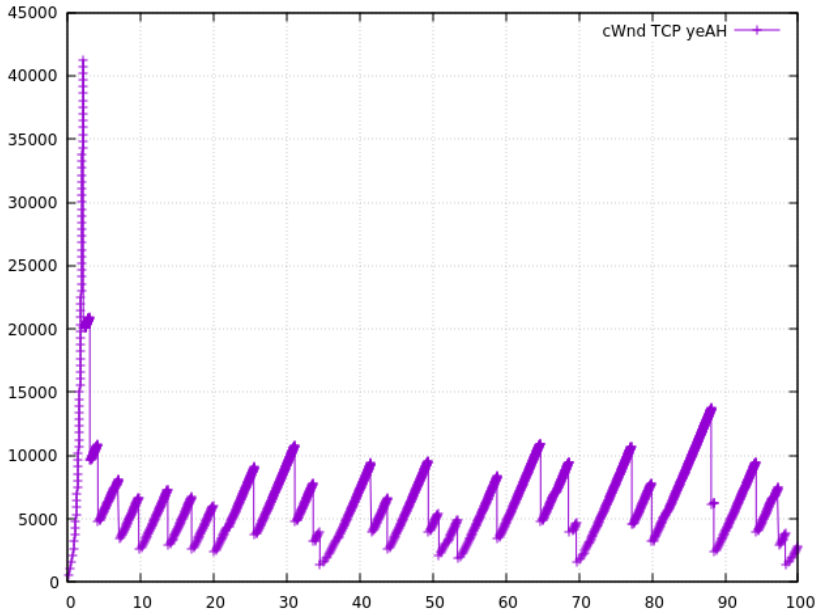
Flow 1 started @ time 0 and runs till time 100. Evolution of the congestion window is plotted against time.



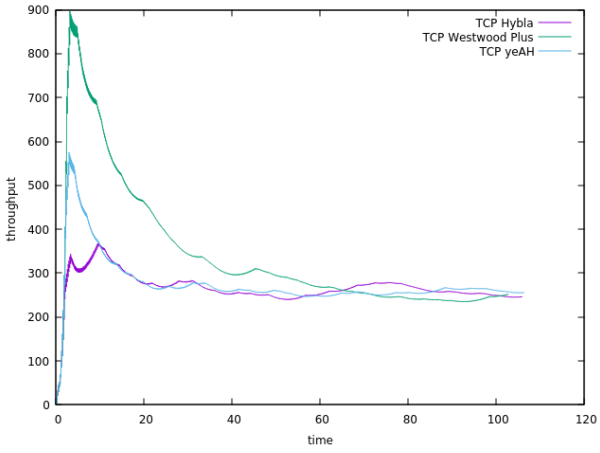
Flow 2 started @ time 100 and runs till time 200. Evolution of the congestion window is plotted against time.



Flow 3 started @ time 200 and runs till time 300. Evolution of the congestion window is plotted against time.



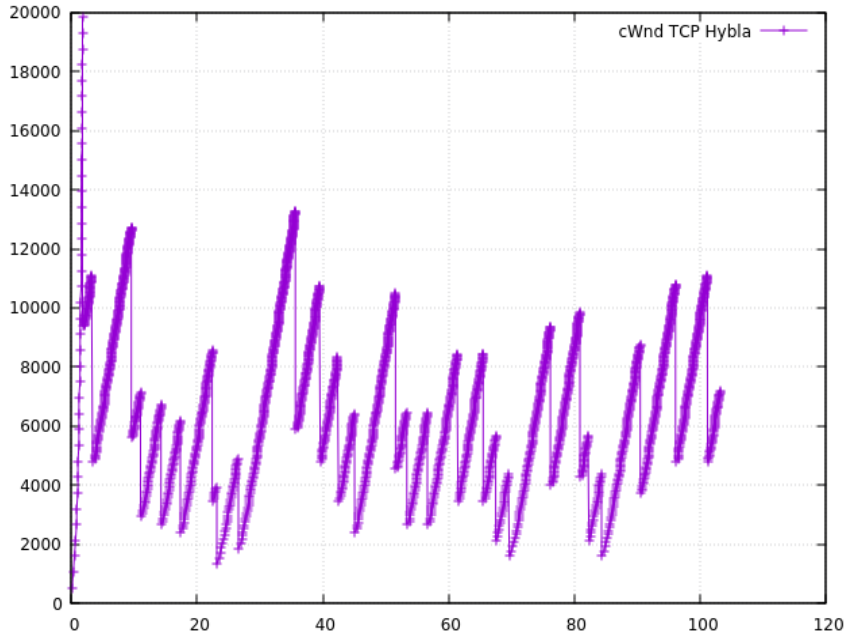
Analysis of throughput for each of the flows :

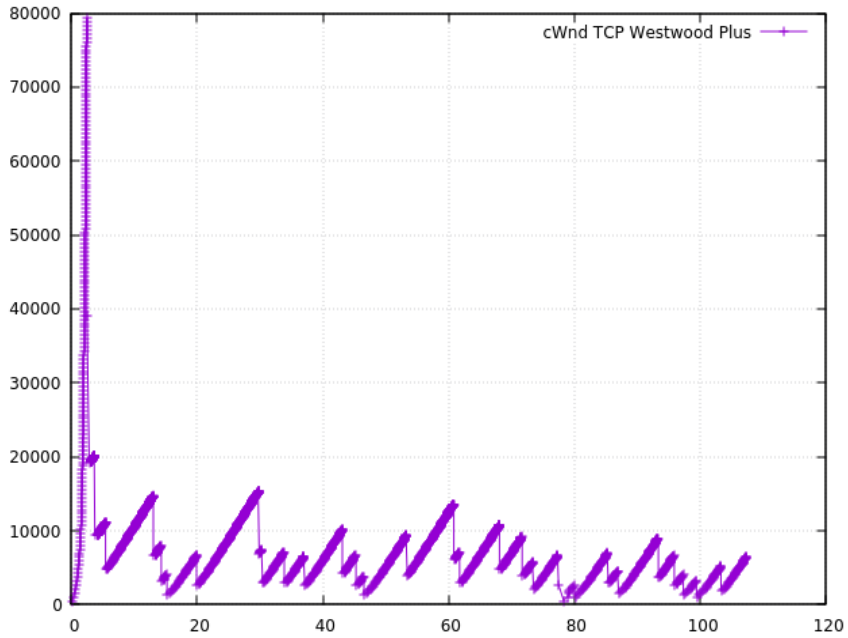


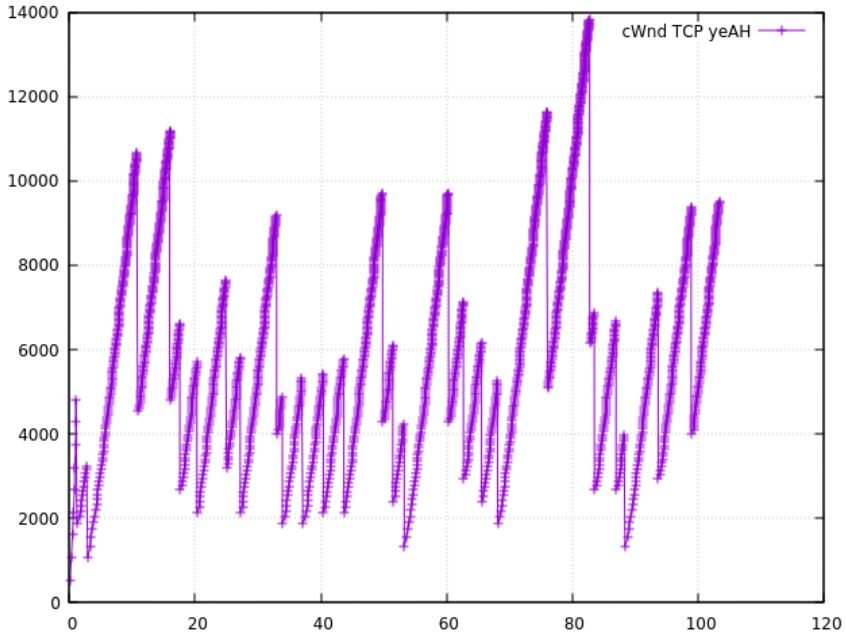
Throughput

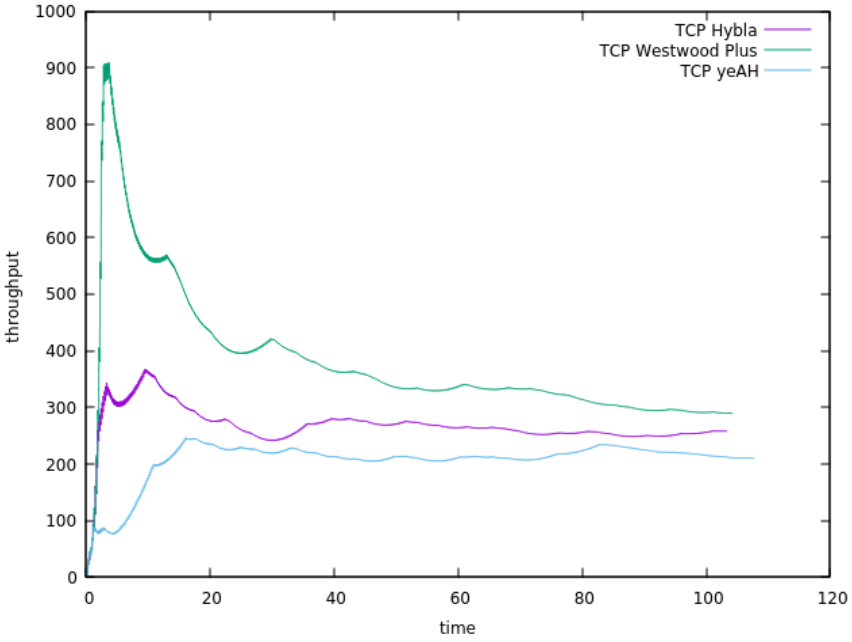
Q2) In the next experiment, start 2 other flows sharing the bottleneck while the first one is in progress and measure the throughput (in Kbps) of each flow. Plot the throughput and evolution of the TCP congestion window for each of the flow at a steady-state. Report is the maximum throughput observed for each of the flows?

Flow 1 started @ time 0 and Flow 2, 3 started @ time 20. Evolution of the congestion window is plotted against time.






cWnd TCP yeAH
14000
12000
10000
8000
6000
4000
2000
0
0
20
40
60
80
100
120


TCP Hybla
TCP Westwood Plus
TCP yeAH
throughput
time
1000
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120

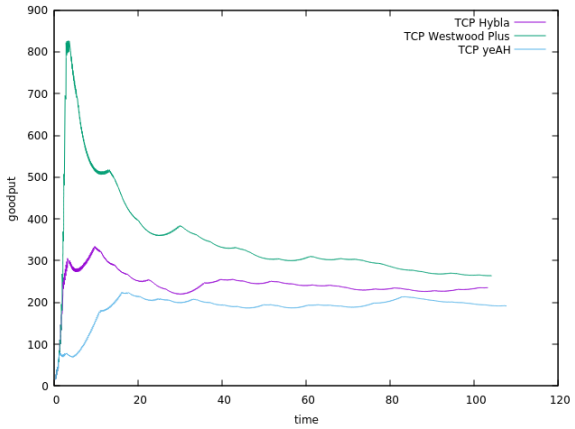
Throughput

The flow statistics observed using ns3 flow monitor are given below.

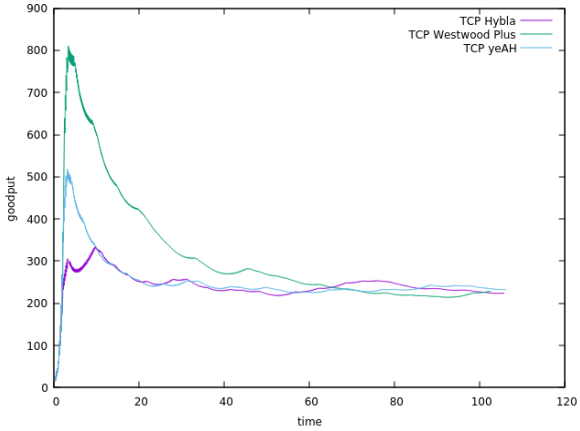
```
TcpReno Flow 1 (10.1.0.1 -> 10.2.0.1)
Packets sent 8737
Packets received 8691
Congestion loss: 40
Max throughput: 367.975

TcpWestwood Flow 3 (10.1.1.1 -> 10.2.1.1)
Packets sent 8775
Packets received 8723
Congestion loss: 46
Max throughput: 903.759

TcpFack Flow 4 (10.1.2.1 -> 10.2.2.1)
Packets sent 8204
Packets received 8162
Congestion loss:  40
Max throughput: 268.942
```

Q3) Measure the congestion loss and Goodput over the duration of the experiment for each of the flows.

Goodput of each of the flows in single flow simulation and multi-flow simulations



Goodput Multi-flow (2)



Goodput Single(1)