

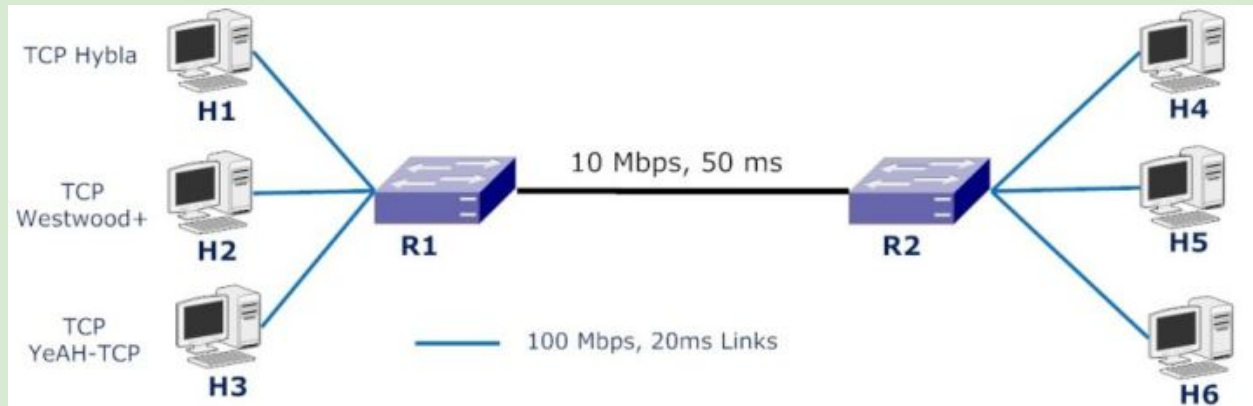
# CS 349 Lab 04

## Group 19 (Application #1)

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Drive link for all the output files and graphs:

<https://drive.google.com/drive/folders/1JCbuSkAGdSllcGbJfPWAq-8Tw8sL8cnL?usp=sharing>

We analyse and compare the three TCP variants- TCP Hybla, TCP Westwood+ and TCP Yeah using network-simulator 3.30.1 . We use droptail queue at both routers, which drops the packets when the router's buffer (queue) gets full. Its size is determined using bandwidth-delay product. We analyse the output until there is no notable difference in the values monitored so far. So we set the duration to 120 seconds for each TCP variant.

IP Header size is: 20

TCP Header size is: 20

TCP ADU size is: 1476

Tx stands for transmitted, Rx stands for received

In all the goodput and throughput graphs below, y-axis has unit Kbps and x-axis in seconds.

## Part 1

We only allow one flow at a time.

### TCP Hybla

Flow 1 (10.0.0.1 -> 10.3.3.2)

Tx Packets: 81395

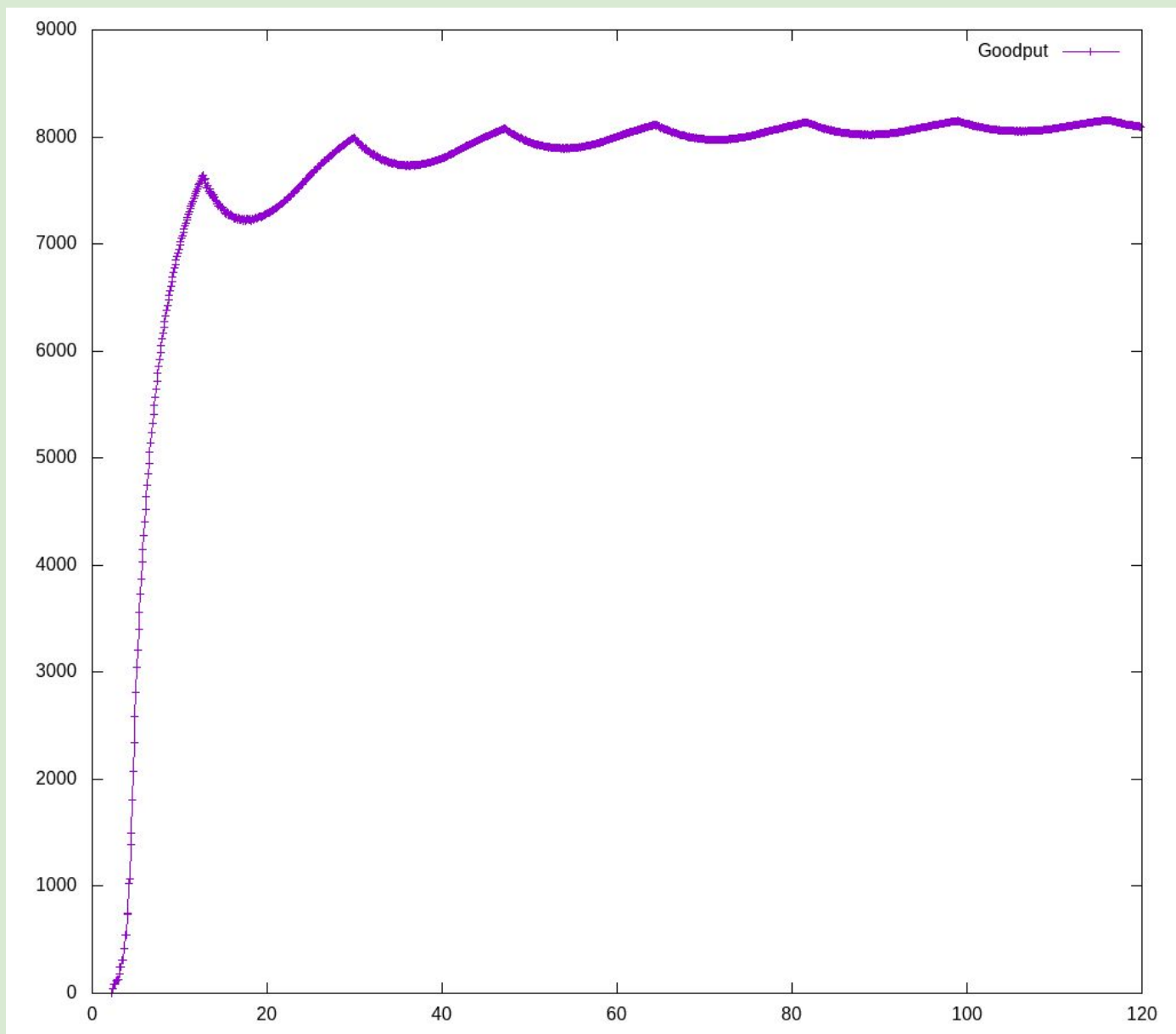
Tx Bytes: 124367136

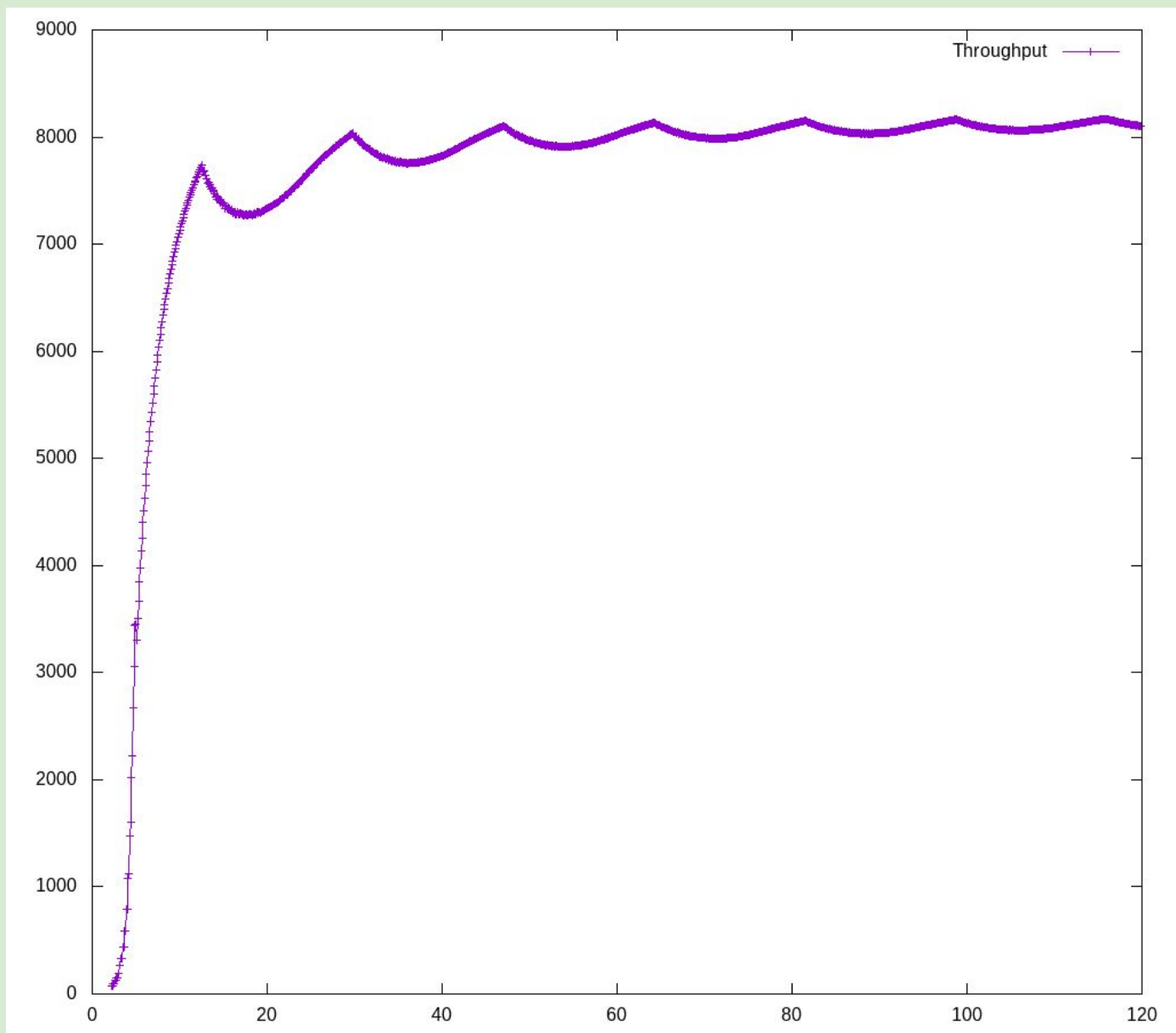
Rx Packets: 81376

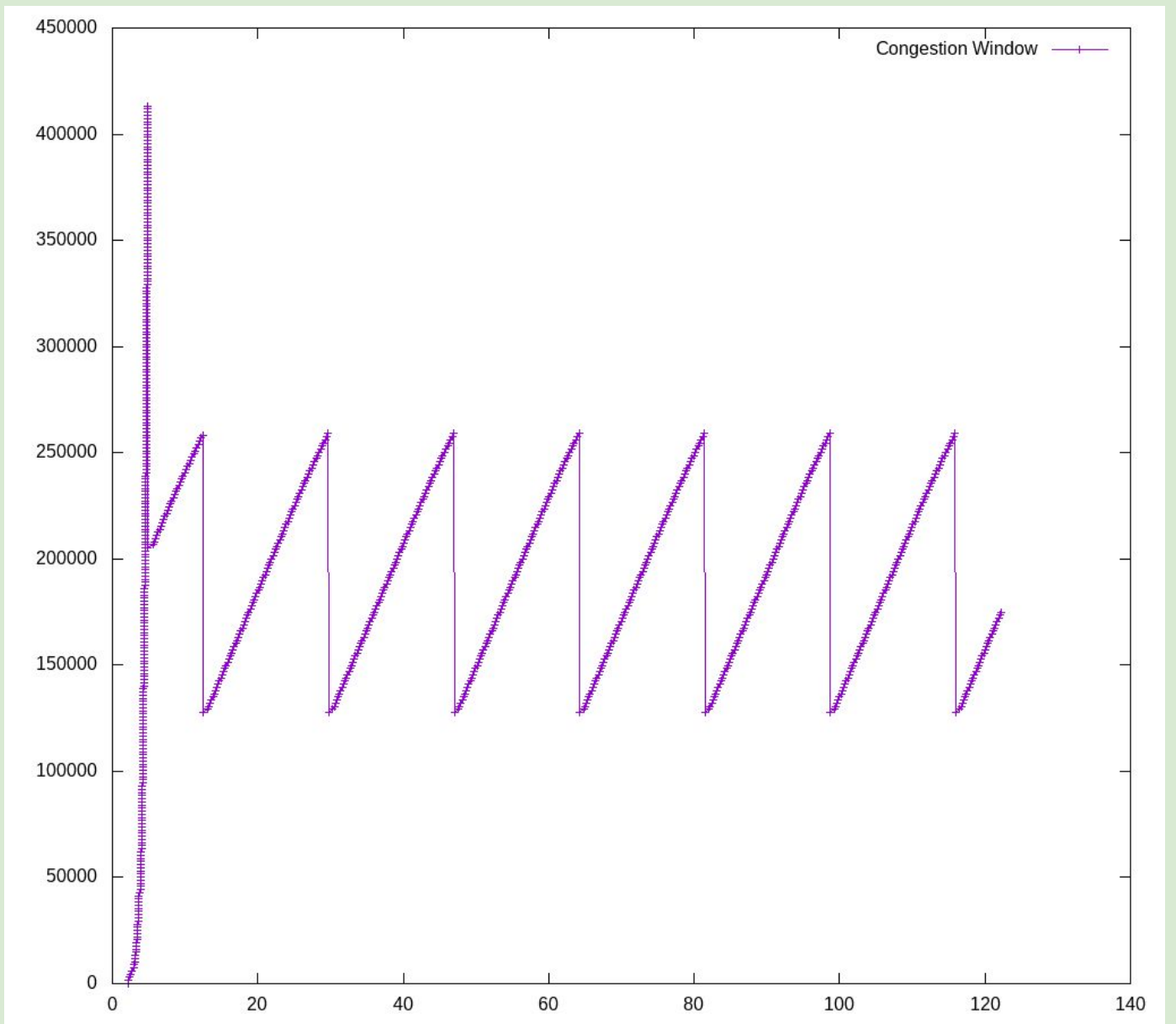
Rx Bytes: 124338104

**Goodput: 7.87609 Mbps**

**Packets Lost due to congestion: 19**







# TCP Westwood+

Flow 3 (10.1.1.1 -> 10.4.4.2)

Tx Packets: 80838

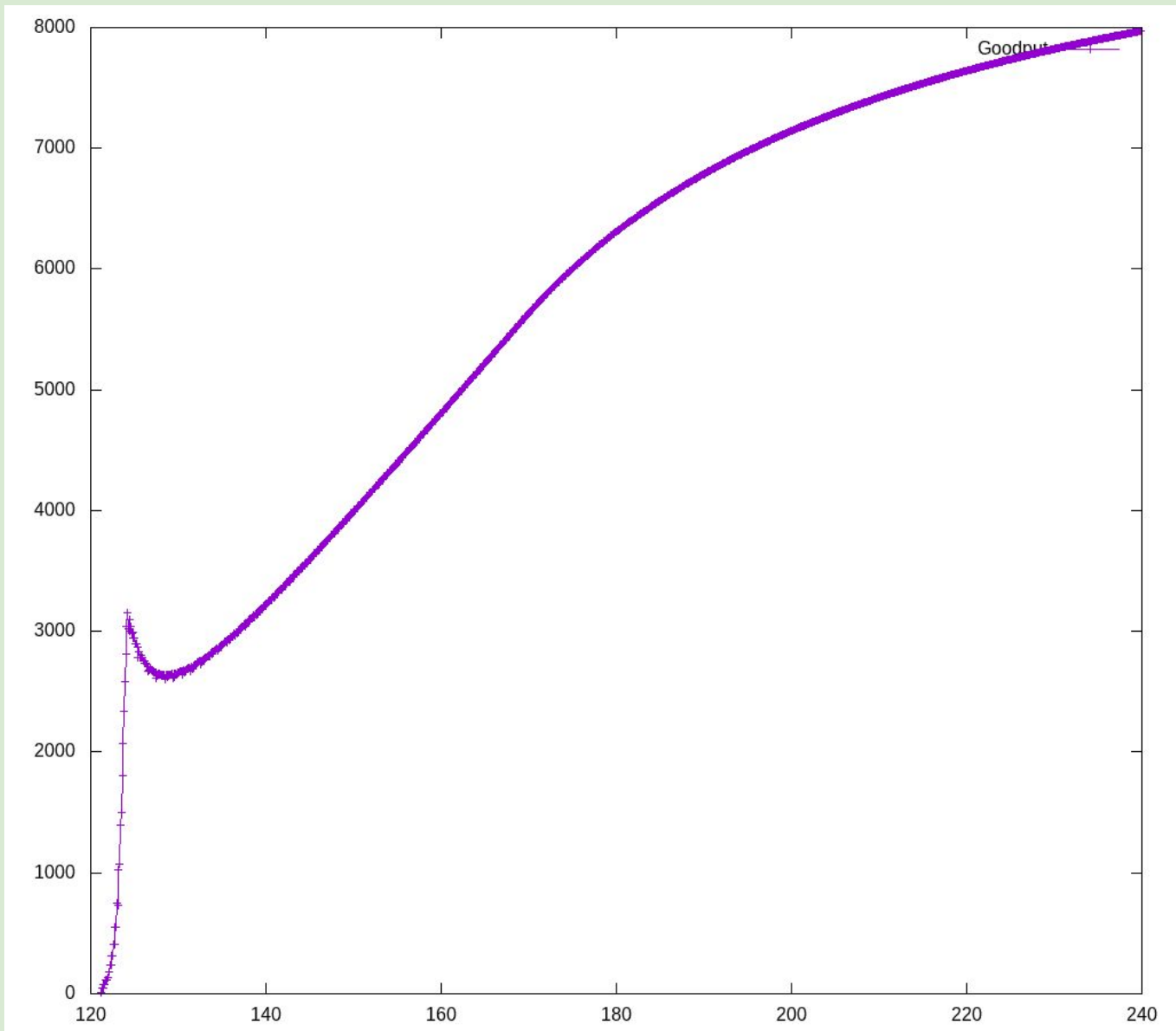
Tx Bytes: 123516040

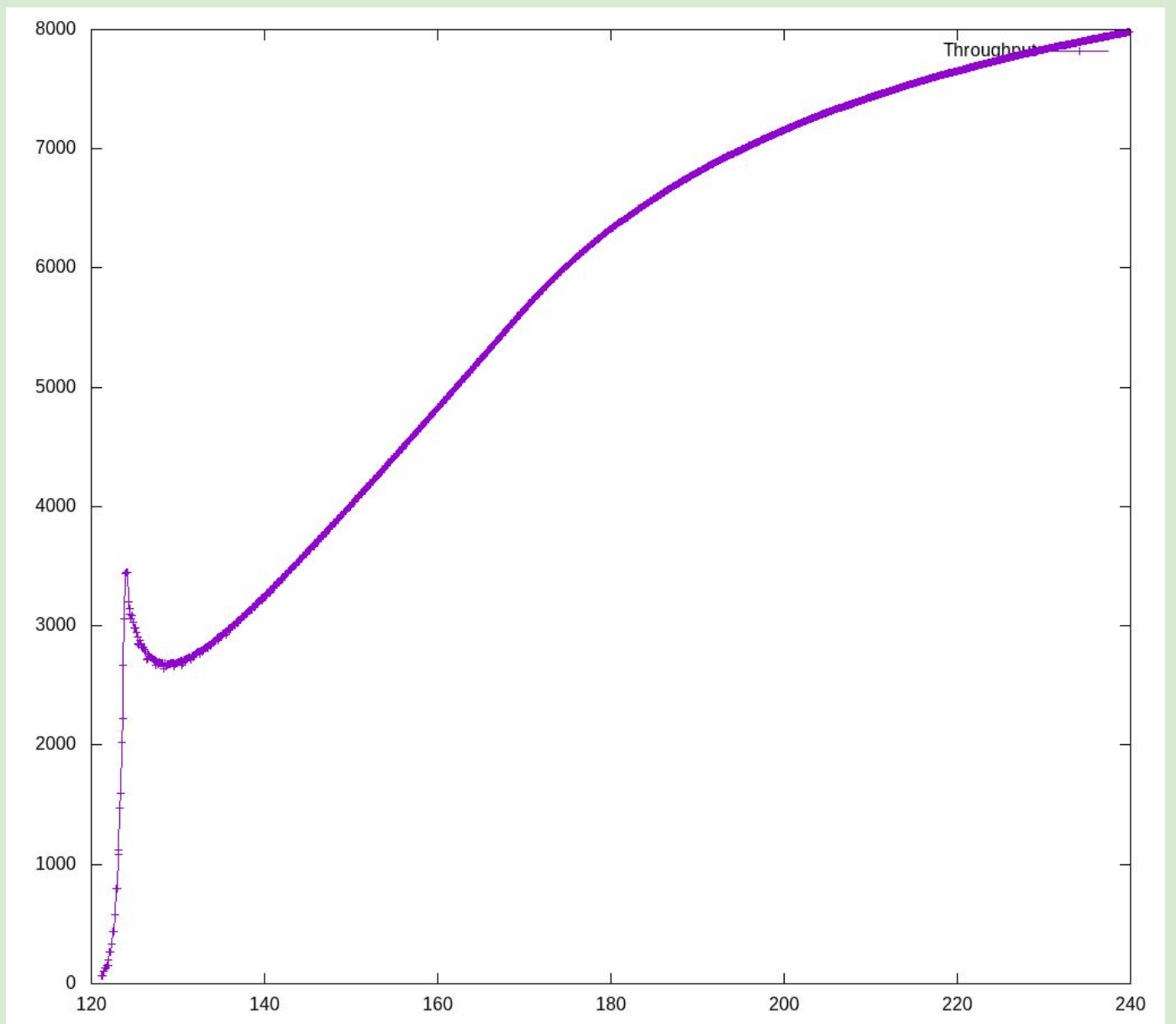
Rx Packets: 80828

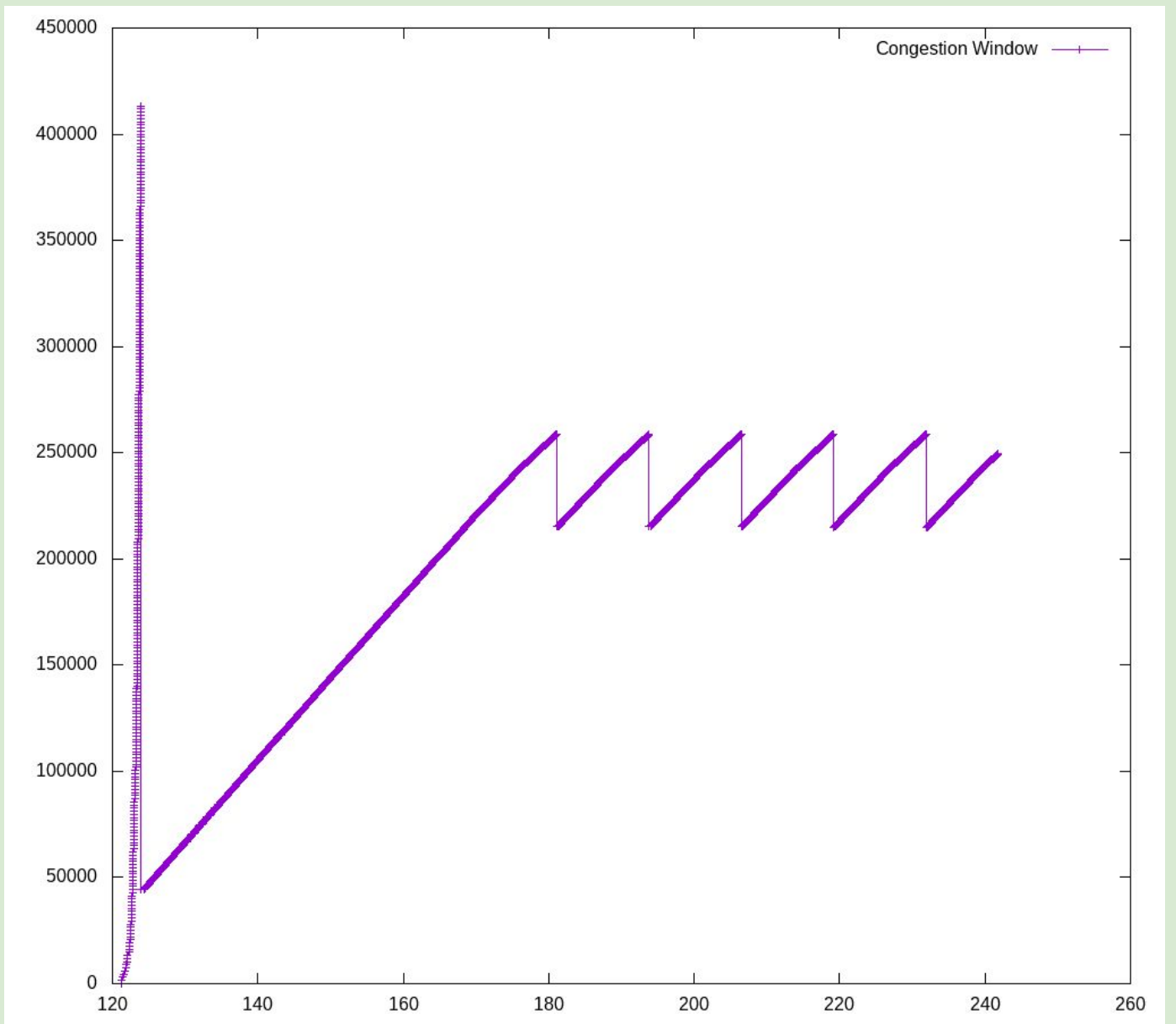
Rx Bytes: 123500760

**Goodput: 7.79655 Mbps**

**Packets Lost due to congestion: 10**









# TCP Yeah

Flow 5 (10.2.2.1 -> 10.5.5.2)

Tx Packets: 82227

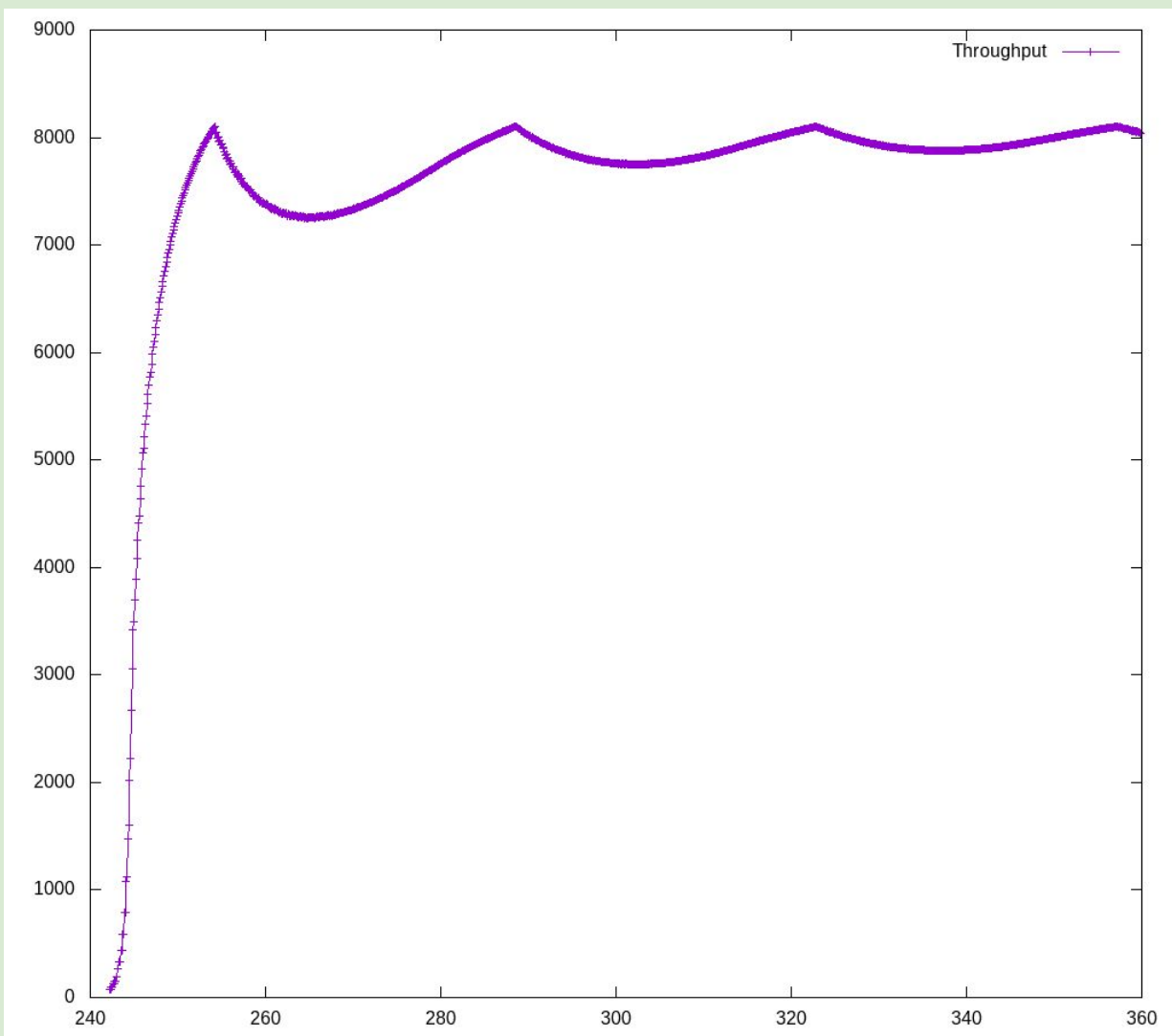
Tx Bytes: 125638432

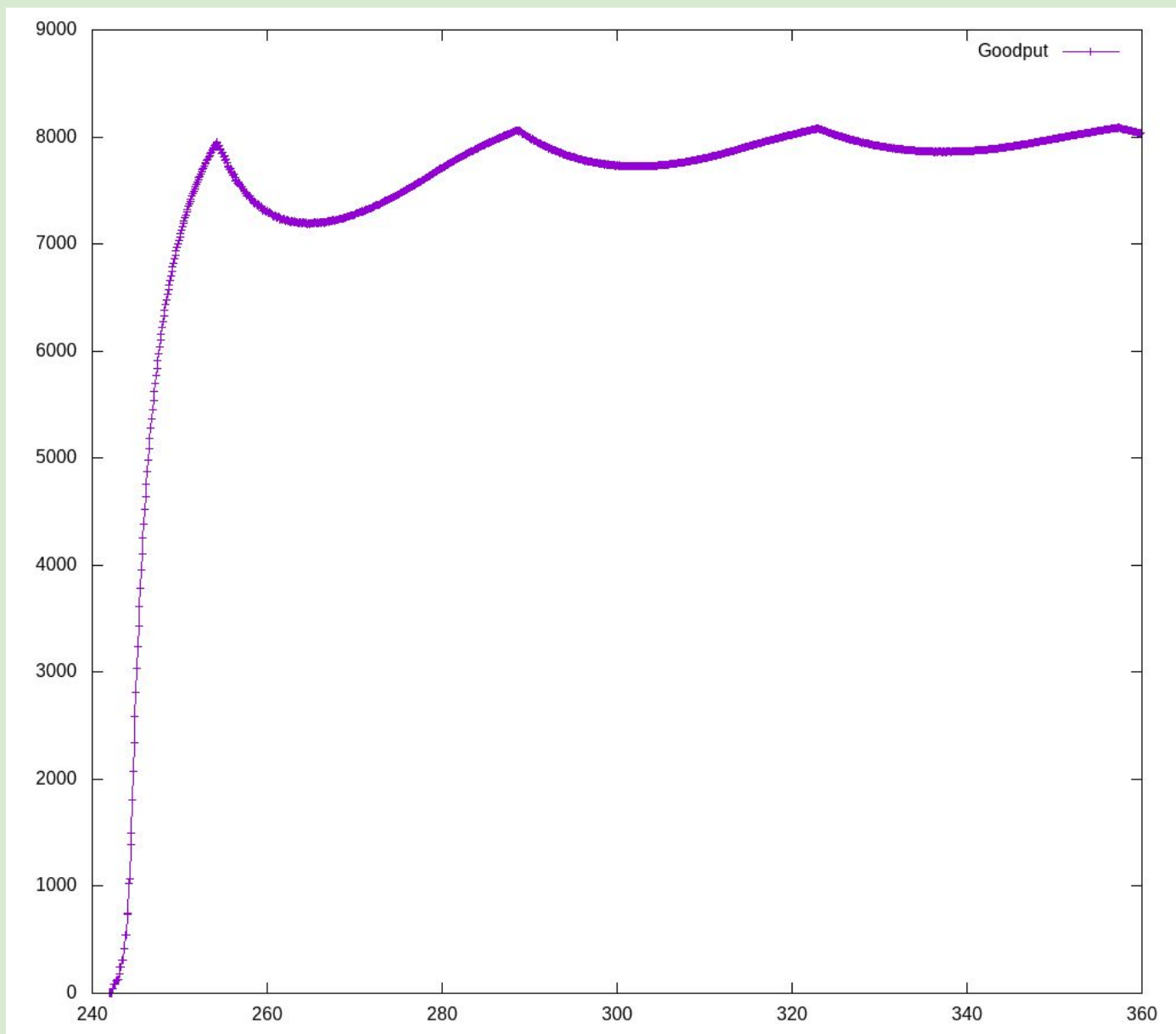
Rx Packets: 82083

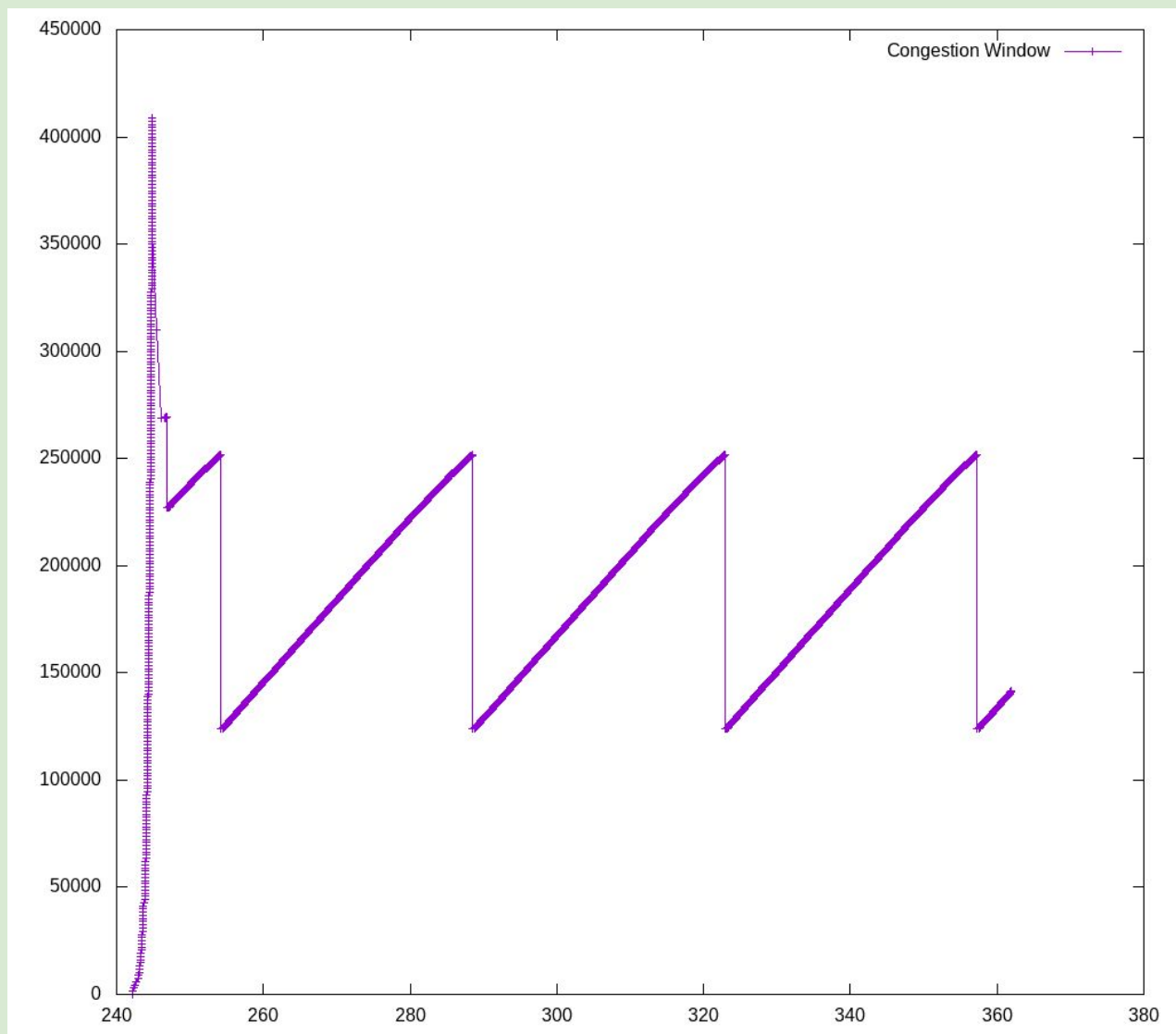
Rx Bytes: 125418400

**Goodput: 7.97391 Mbps**

**Packets Lost due to congestion: 72**







As we observe, throughput and goodput reach saturation after a certain time. Throughput is the amount of total data that flows per unit time, while goodput is the amount of actual usable data that flows per unit time, so they both follow almost the same trend as confirmed from the above graphs. Size of congestion window follows an additive increase and multiplicative decrease pattern.

**Max Throughput for TCP Hybla: 8171.31 Kbps**

**Max Throughput for TCP Westwood: 7981.61 Kbps**

**Max Throughput for TCP Yeah: 8243.52 Kbps**

## Part 2

We shall start with one flow and start the second flow after 10 seconds and third flow after 10 more seconds. All the three flows now share the common bottleneck link.

### TCP Hybla

Flow 1 (10.0.0.1 -> 10.3.3.2)

Tx Packets: 35245

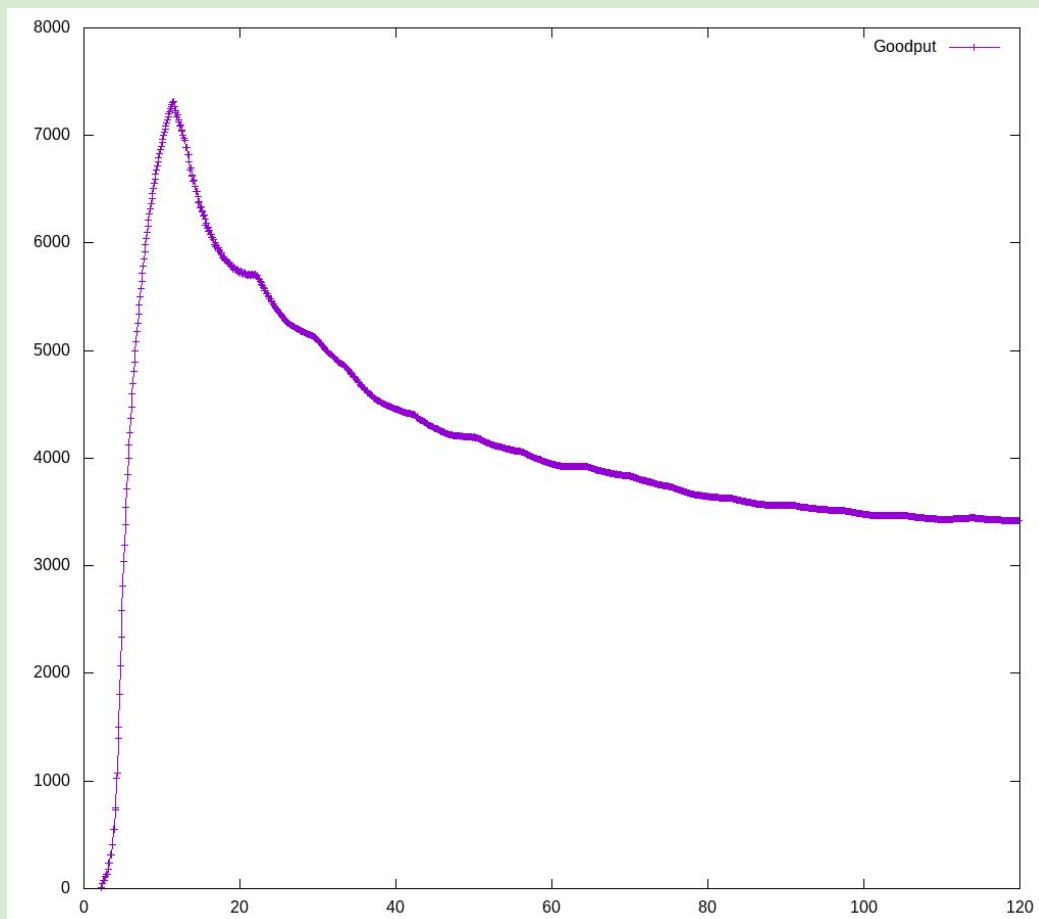
Tx Bytes: 53849936

Rx Packets: 35209

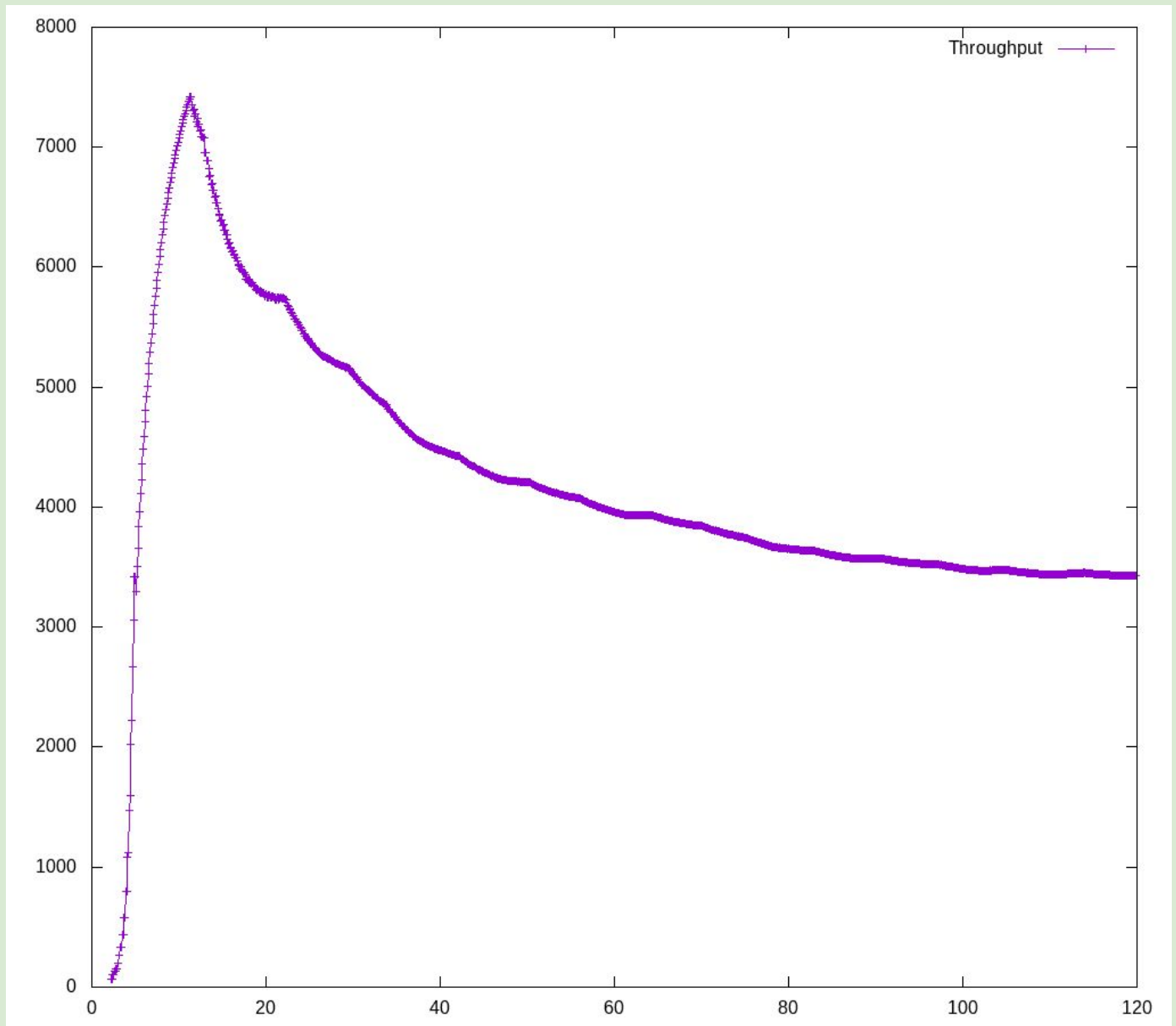
Rx Bytes: 53794928

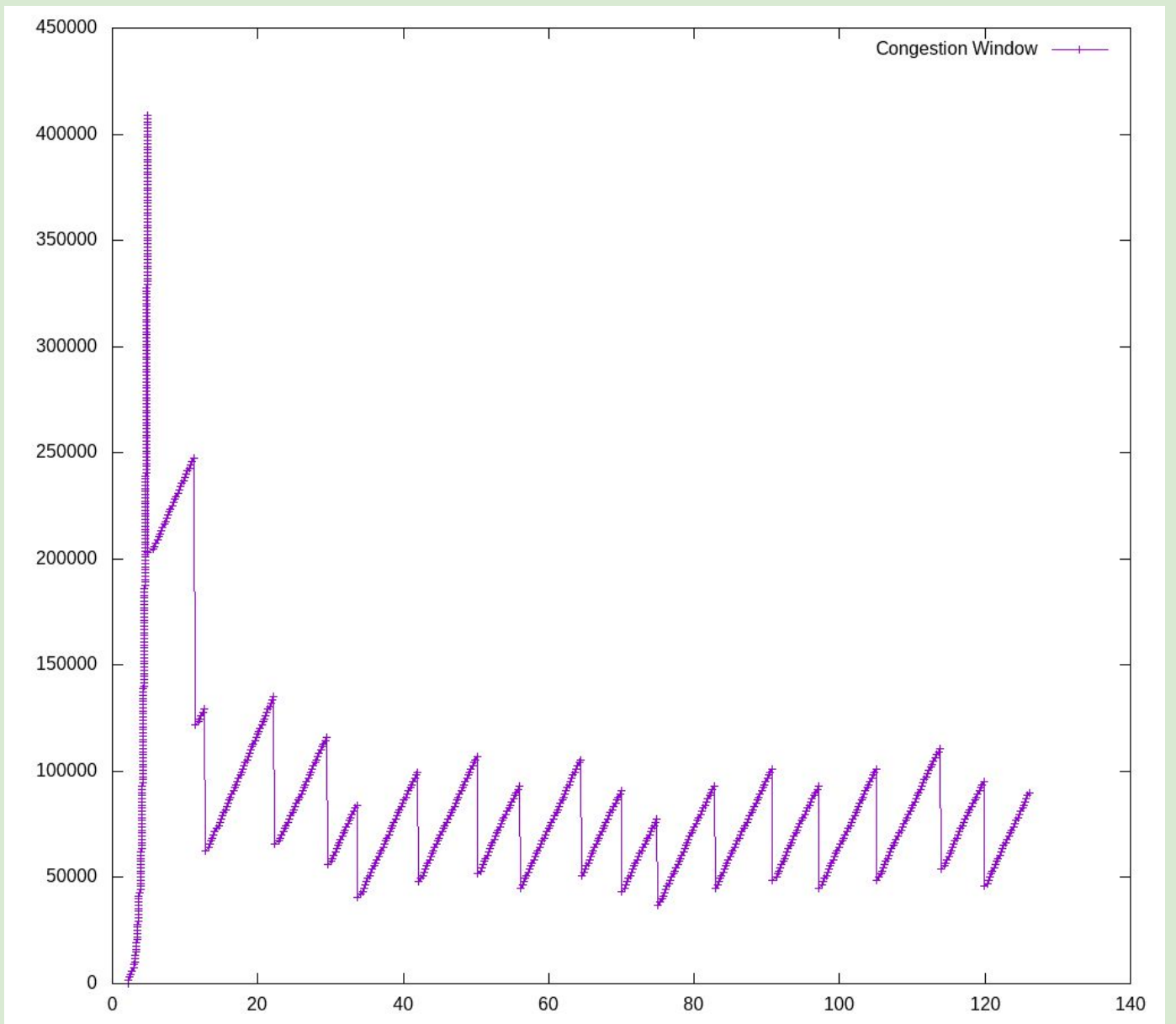
**Goodput: 3.30538 Mbps**

**Packets Lost due to congestion : 36**



As we notice graph initially reaches a throughput of 8Mbps when it is the only flow running, after 20 seconds when the other two flows start its throughput falls.





## TCP Westwood +

Flow 3 (10.1.1.1 -> 10.4.4.2)

Tx Packets: 48230

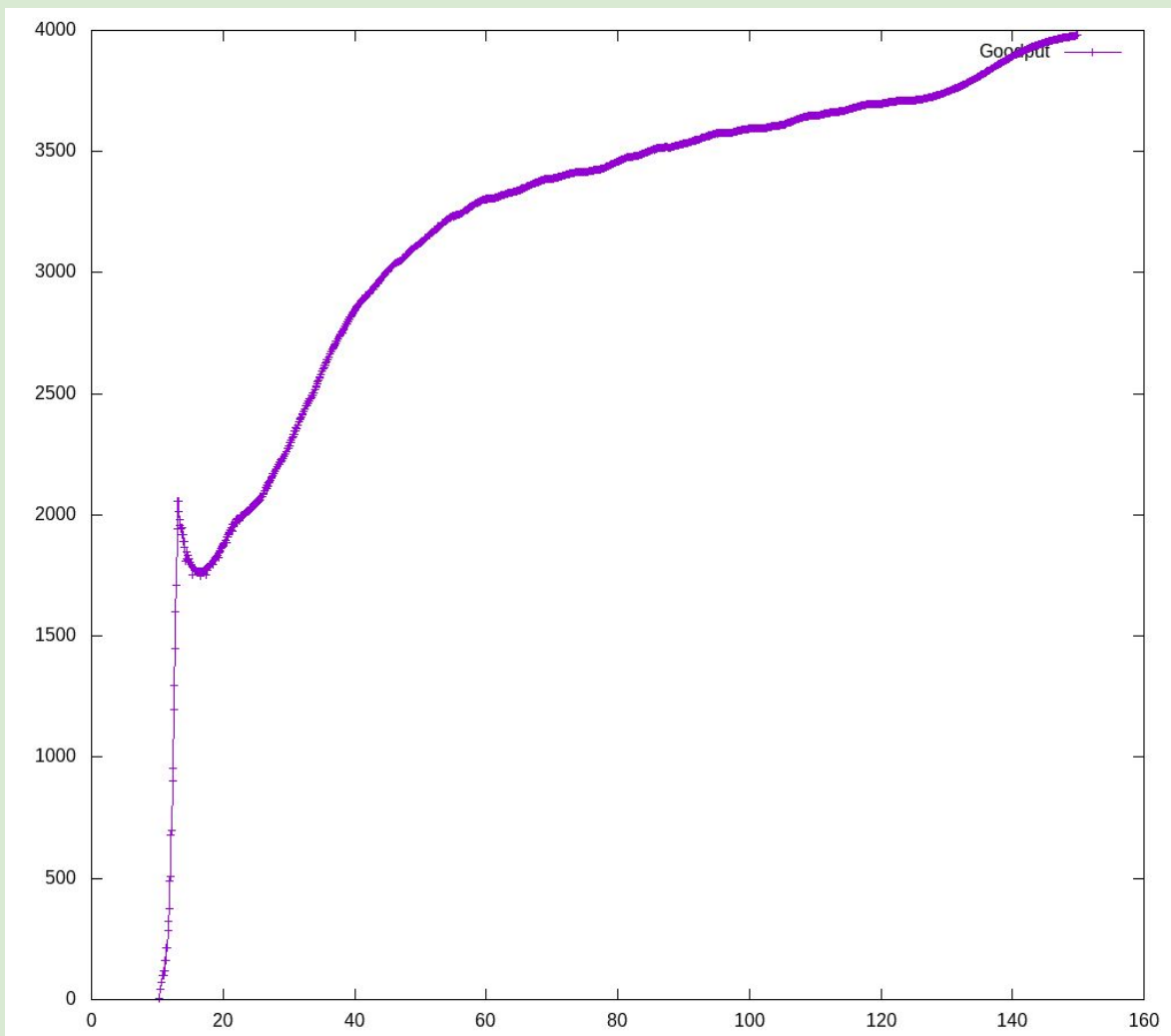
Tx Bytes: 73691016

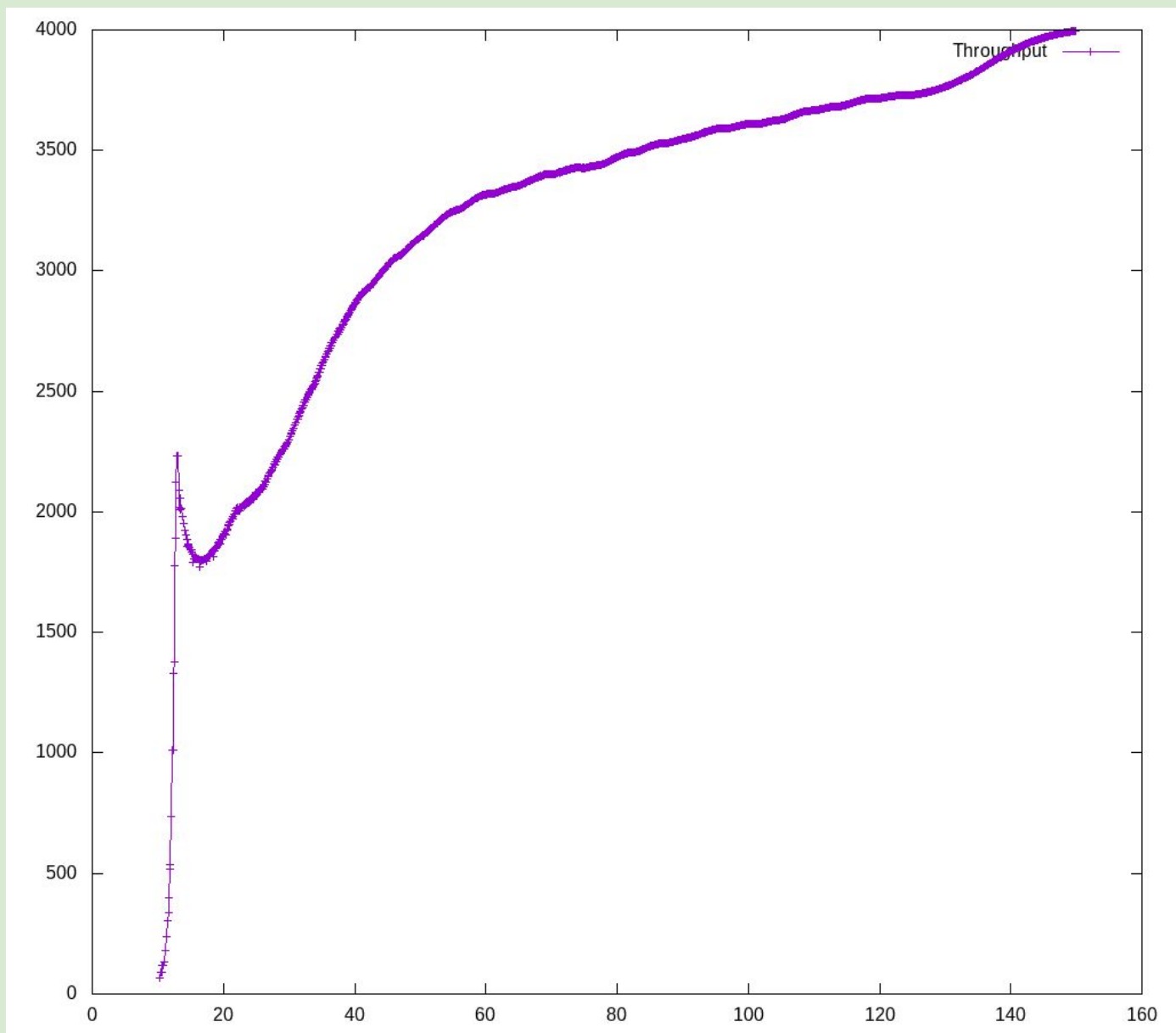
Rx Packets: 48079

Rx Bytes: 73460288

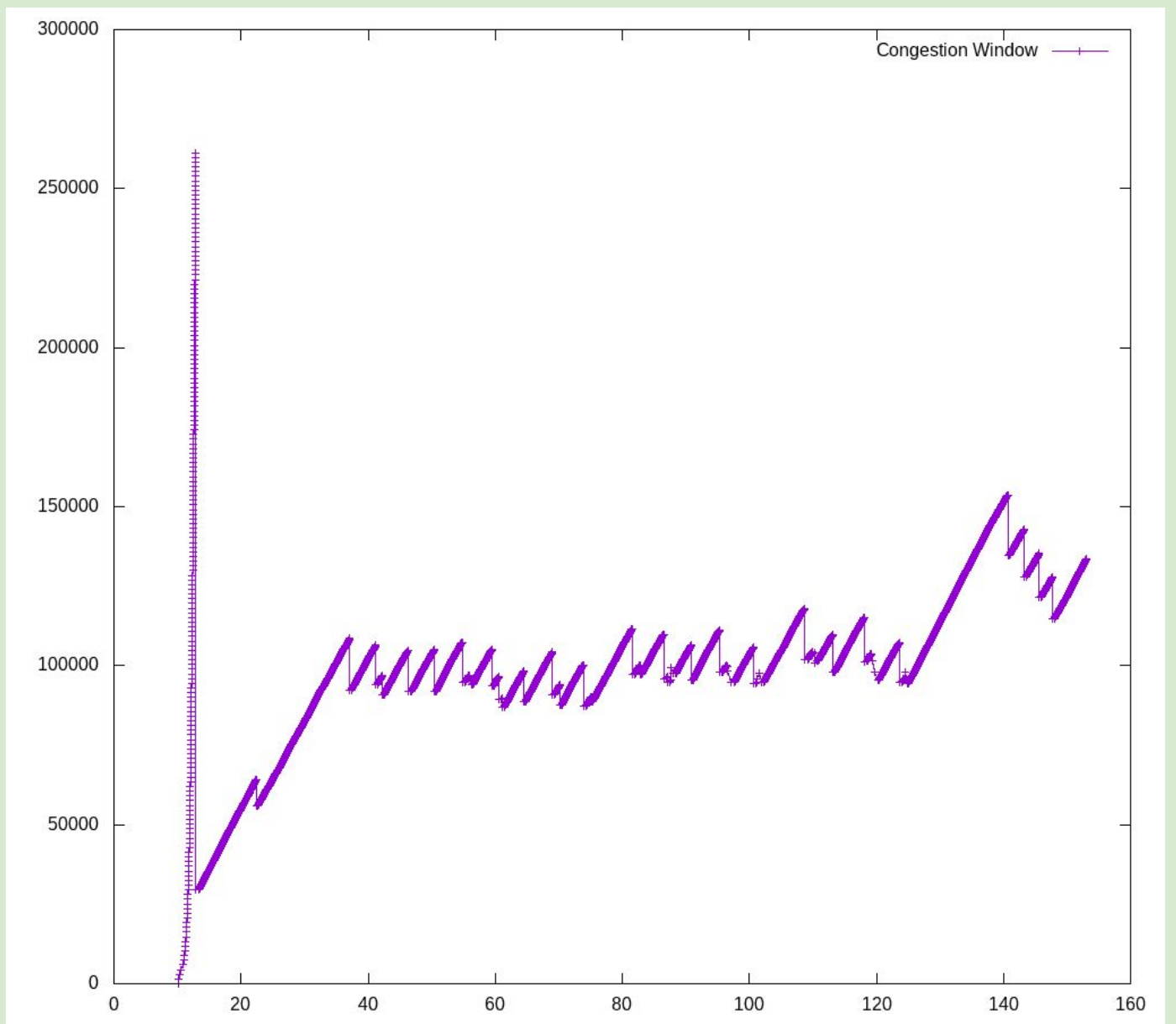
**Goodput: 3.91508 Mbps**

**Packets Lost due to congestion : 151**









# TCP Yeah

Flow 5 (10.2.2.1 -> 10.5.5.2)

Tx Packets: 58132

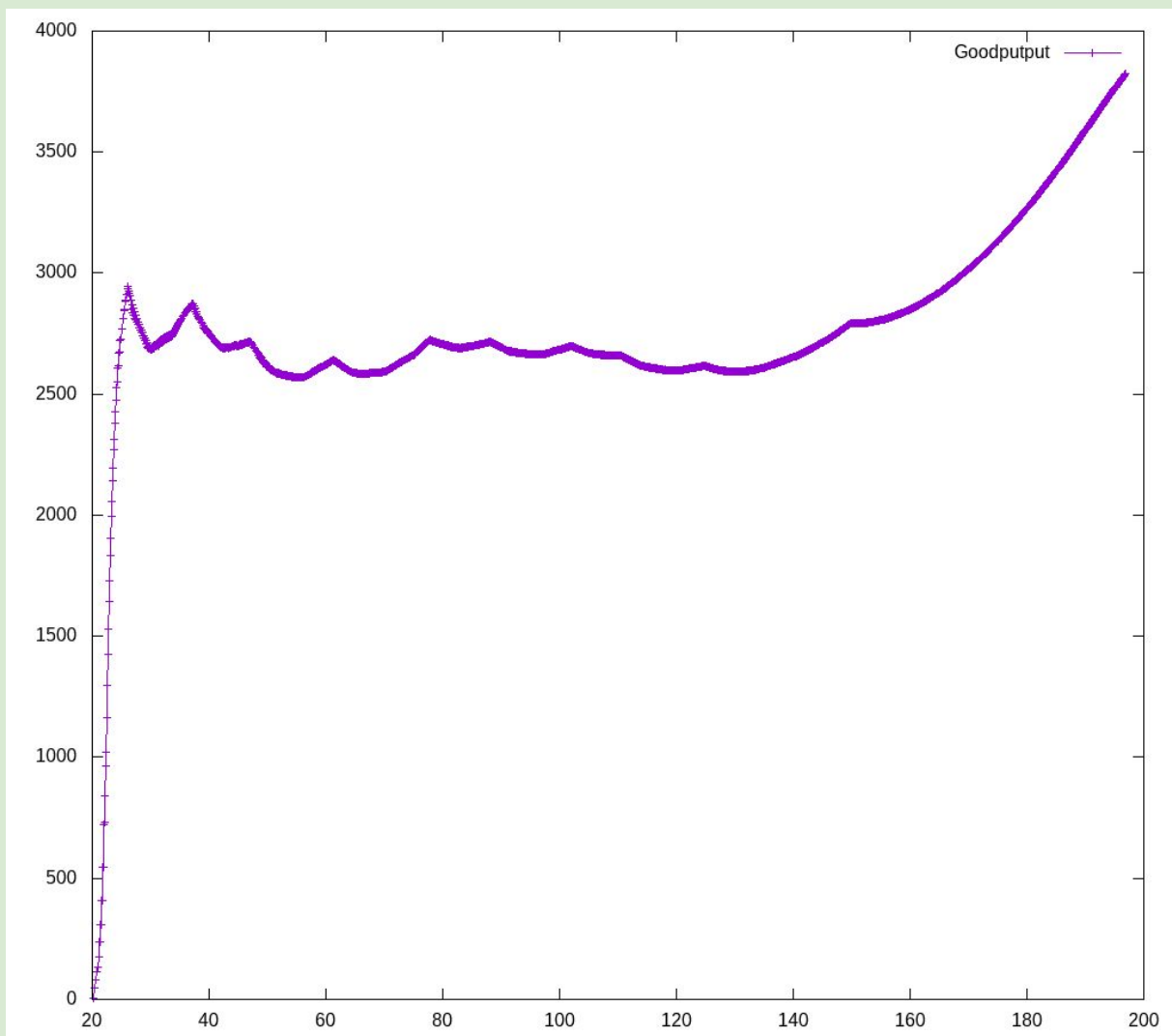
Tx Bytes: 88821272

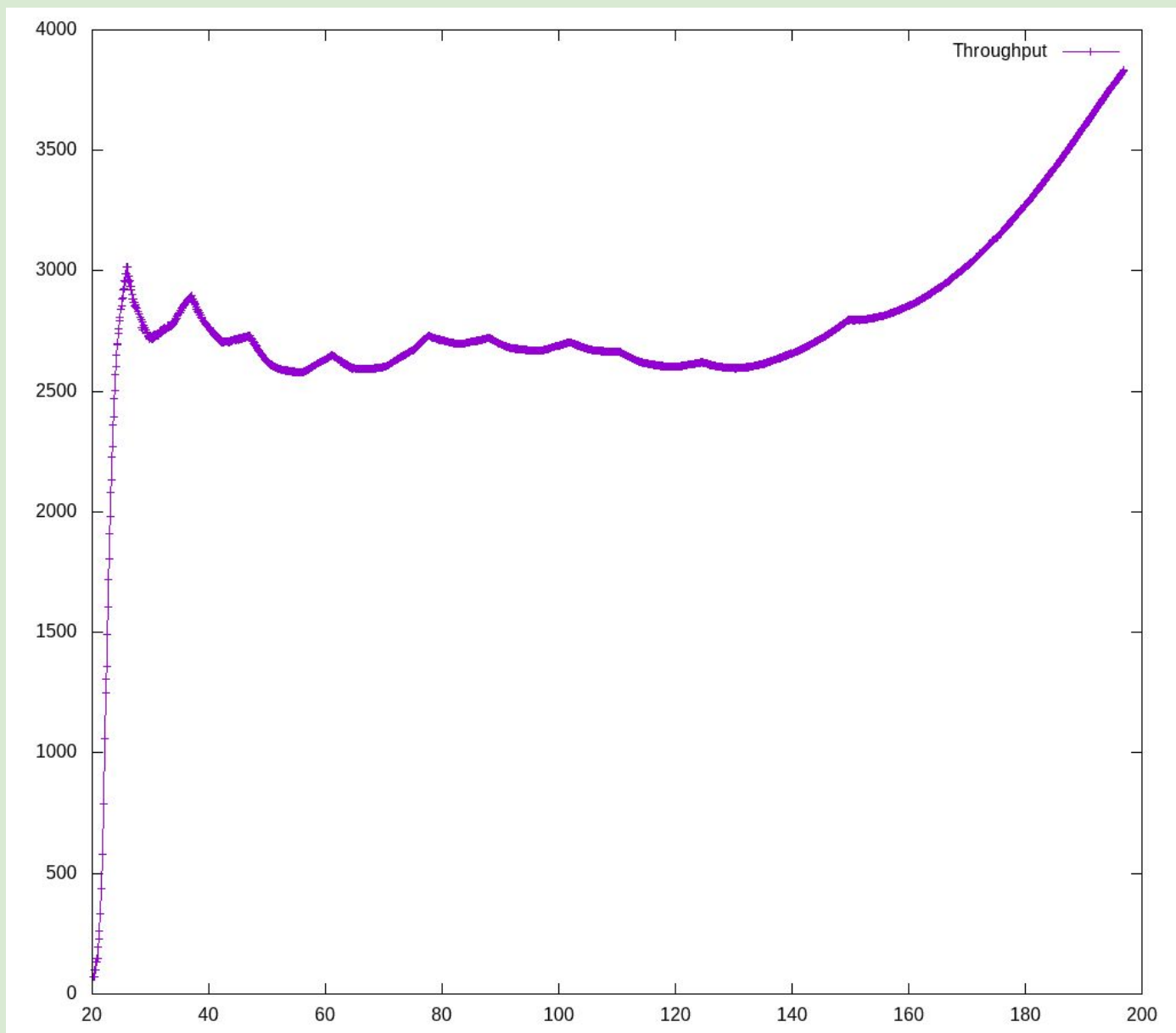
Rx Packets: 58116

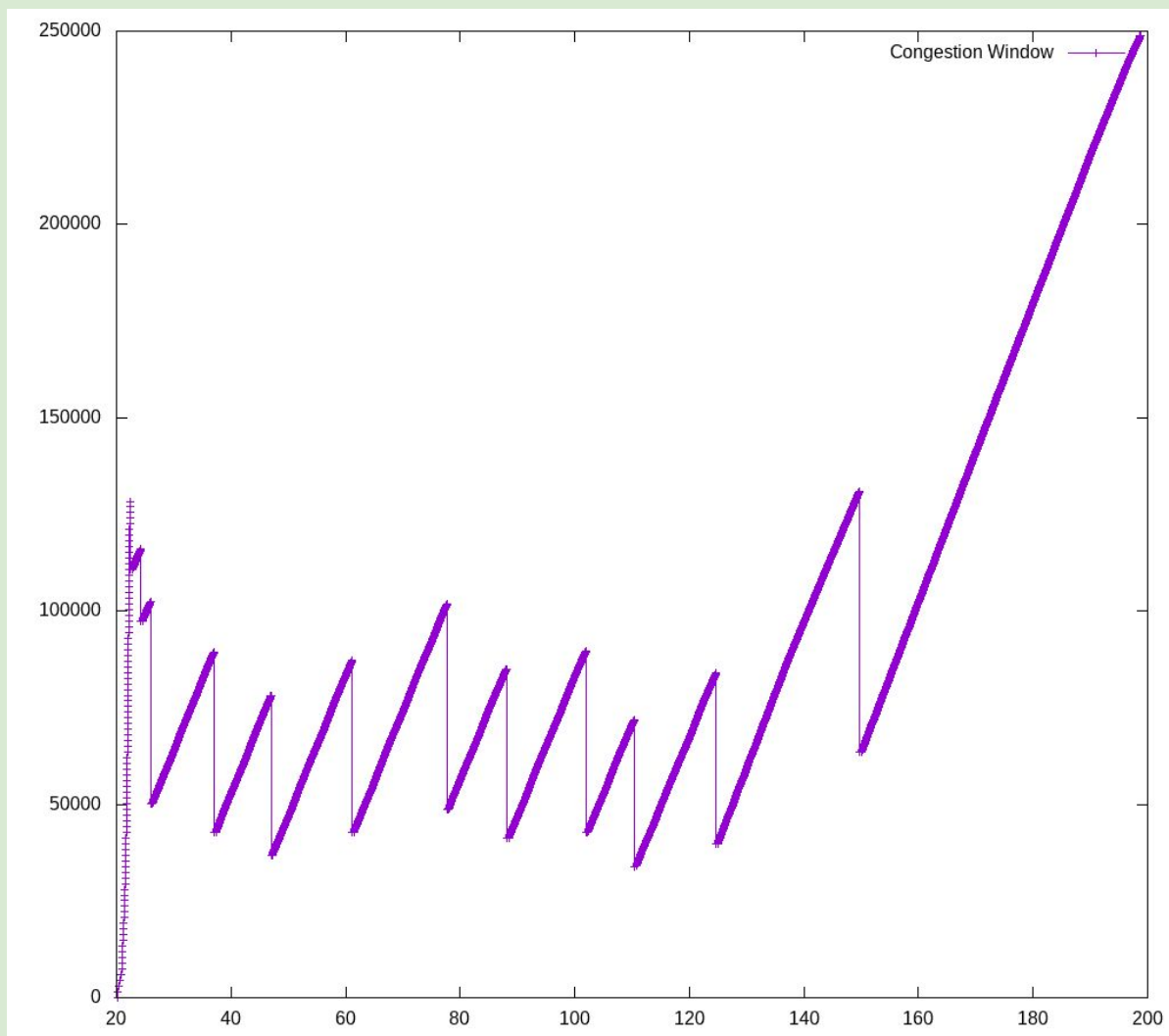
Rx Bytes: 88796824

**Goodput: 3.78787 Mbps**

**Packets Lost due to congestion : 16**







**Max Throughput for TCP Hybla: 7421.11Kbps**

**Max Throughput for TCP Westwood: 3996.77Kbps**

**Max Throughput for TCP Yeah: 3832.51Kbps**

We observe that the average throughput for all three TCP variants settle at a value significantly less (3.3-3.9 Mbps) than their values in part 1 (7.7-7.9 Mbps) because all the three flows share common bottleneck. Maximum throughput of TCP Hybla is quite high because it is attained in the initial 10 seconds, when it is the only flow running, its average throughput is almost equal to that of the other two variants.