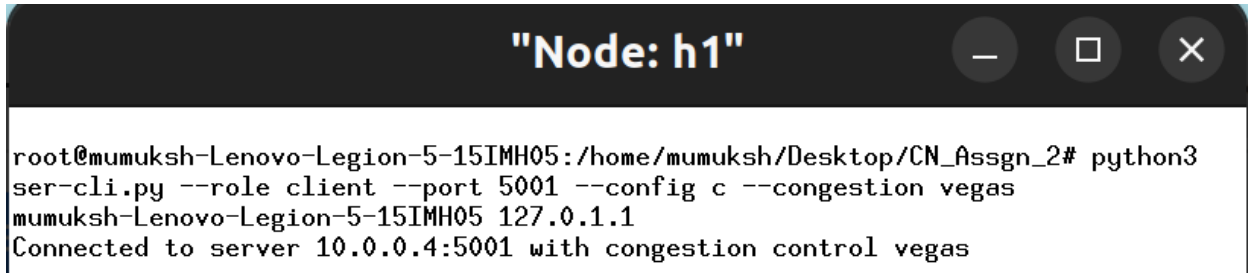


Q2)

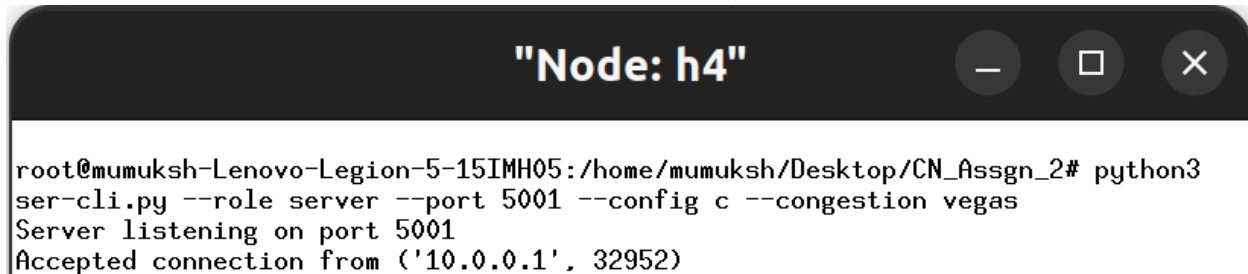
(a) Python implementation for custom topology and server-client script uploaded on the github repository with steps

XTerm interface for client

A screenshot of an XTerm window titled "Node: h1". The window has standard Linux window controls (minimize, maximize, close) in the top right corner. The terminal content shows a user at the prompt 'root@mumuksh-Lenovo-Legion-5-15IMH05' running the command 'python3 ser-cli.py --role client --port 5001 --config c --congestion vegas'. The output shows the IP address 'mumuksh-Lenovo-Legion-5-15IMH05 127.0.1.1' and a confirmation message 'Connected to server 10.0.0.4:5001 with congestion control vegas'.

Client side command to run

XTerm interface for server

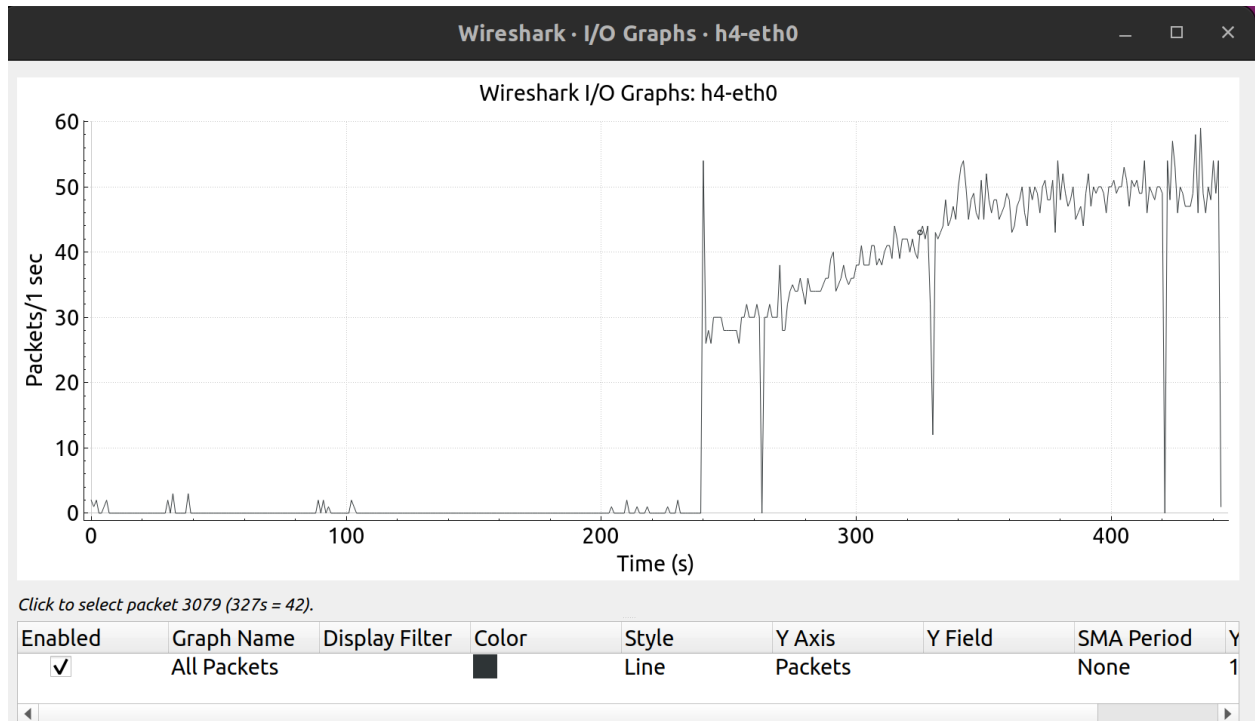
A screenshot of an XTerm window titled "Node: h4". The window has standard Linux window controls (minimize, maximize, close) in the top right corner. The terminal content shows a user at the prompt 'root@mumuksh-Lenovo-Legion-5-15IMH05' running the command 'python3 ser-cli.py --role server --port 5001 --config c --congestion vegas'. The output shows 'Server listening on port 5001' and 'Accepted connection from ('10.0.0.1', 32952)'.

Server side command to run

(b) Throughput for various congestion control schemes (Vegas, Reno, Cubic, BBR) (Config=b for all of the following throughputs)

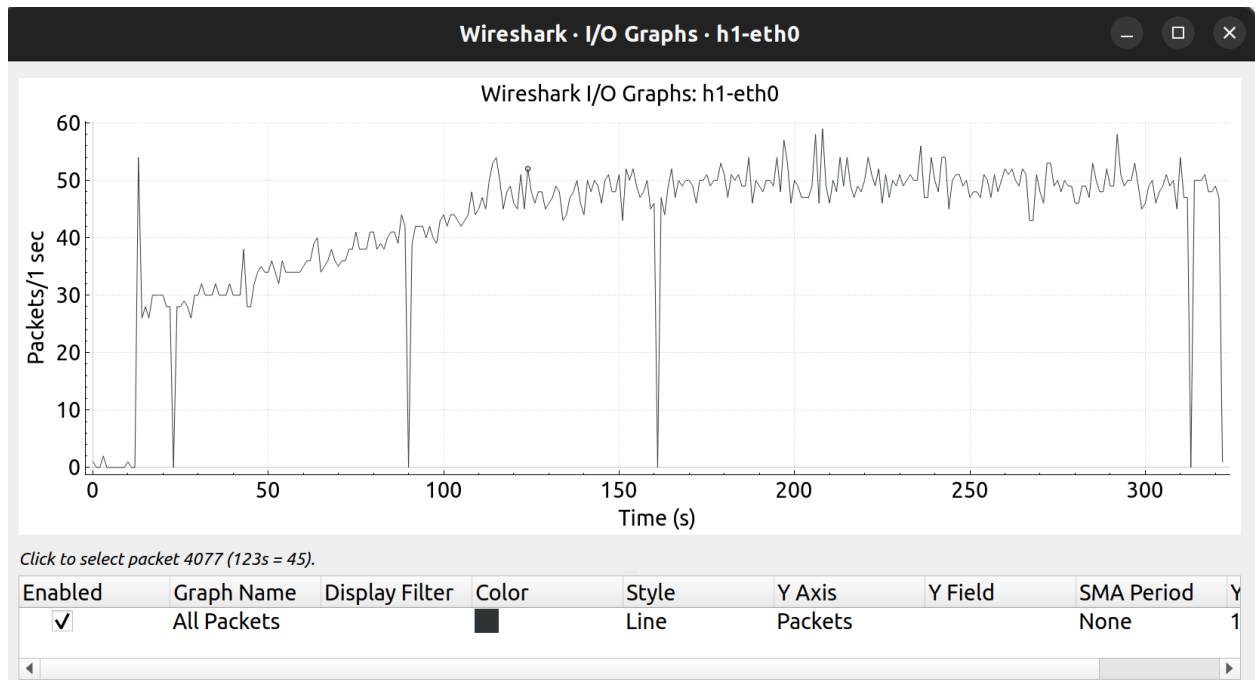
Congestion=Vegas

H4 (Server Side)



Packets/sec received vs Time plot for server side (Initial rate of 0 is because of no packets being transferred in that duration)

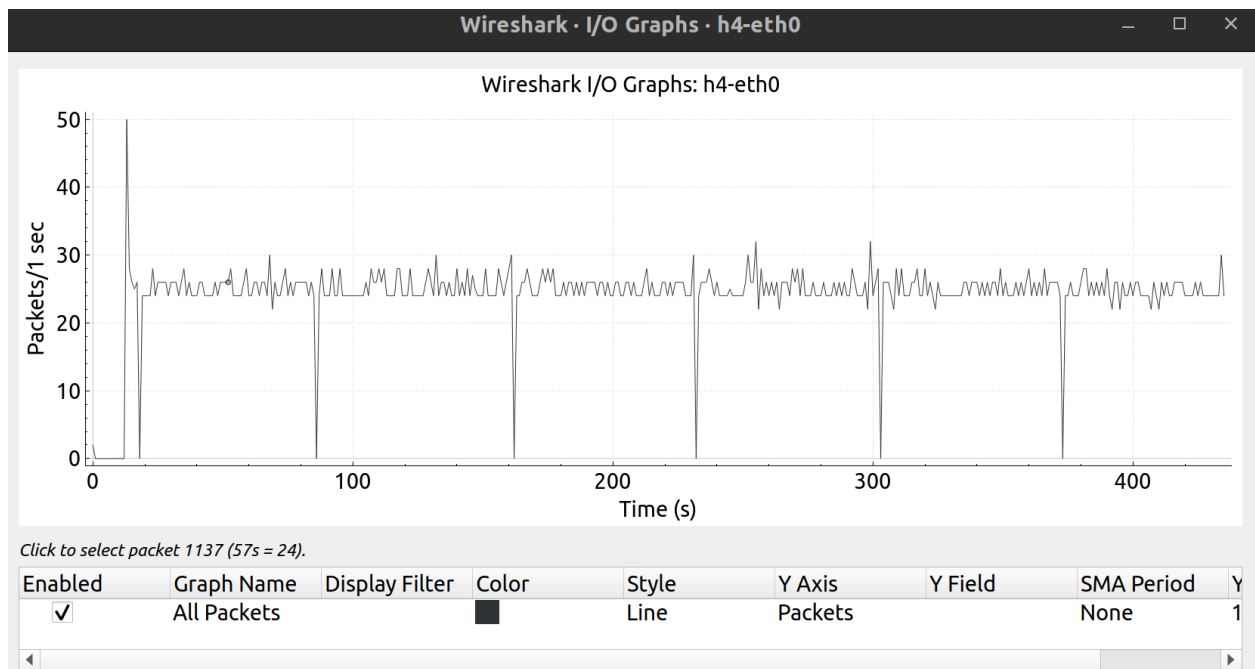
H1 (Client Side)



Packets/sec sent vs Time plot for client side

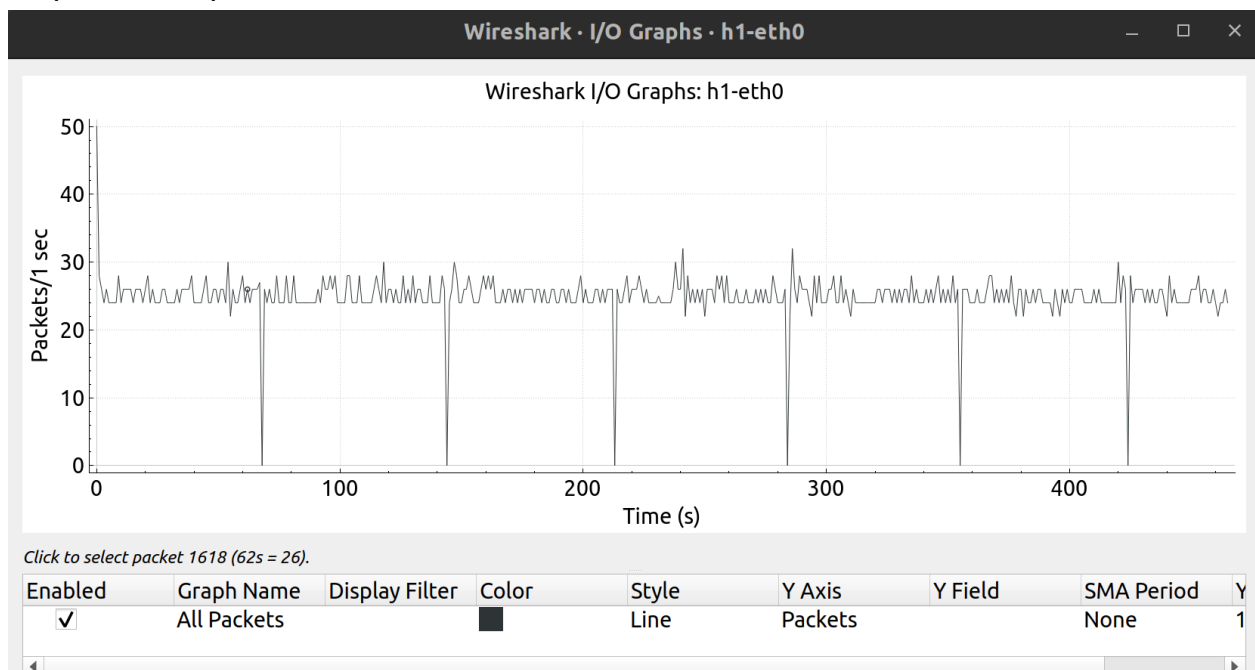
Congestion=Reno

H4 (Server Side)



Packets/sec received vs Time plot for server side

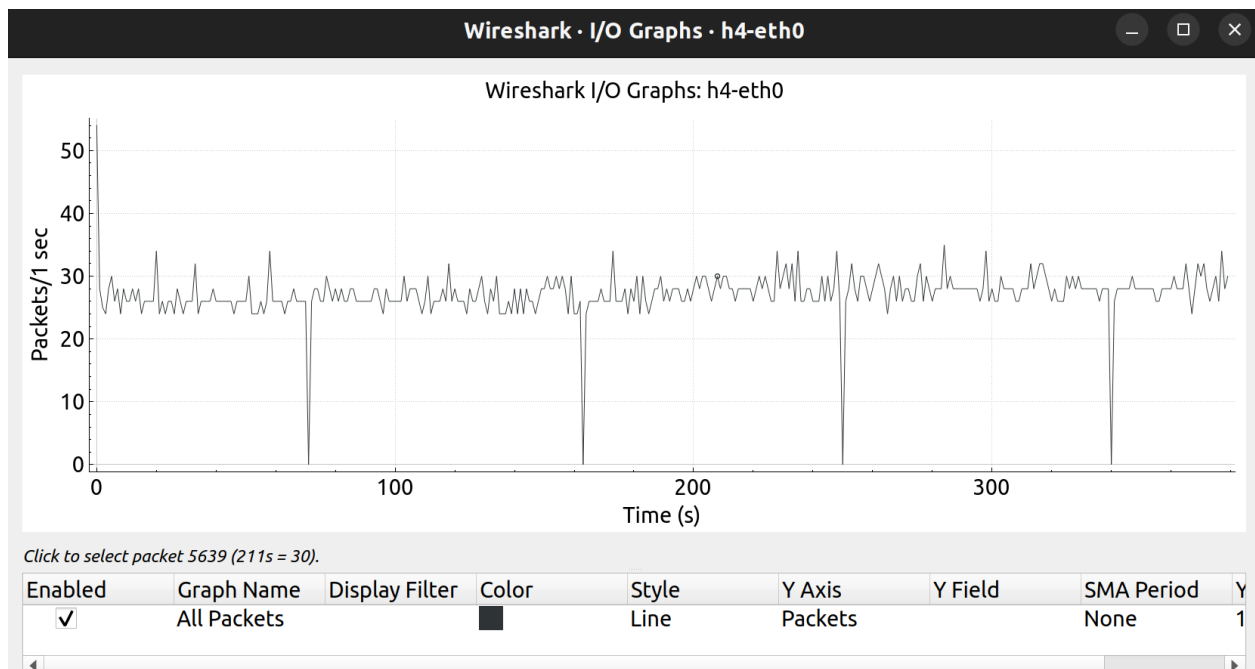
H1 (Client Side)



Packets/sec sent vs Time plot for client side

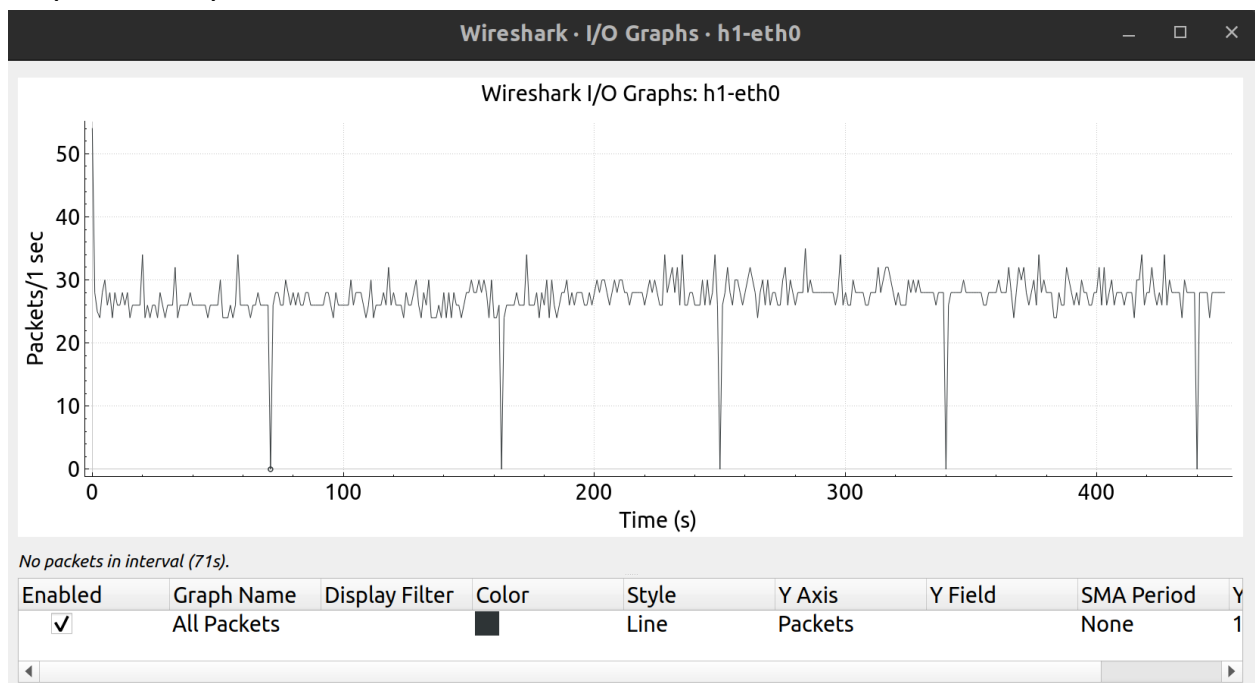
Congestion=Cubic

H4 (Server Side)



Packets/sec received vs Time plot for server side

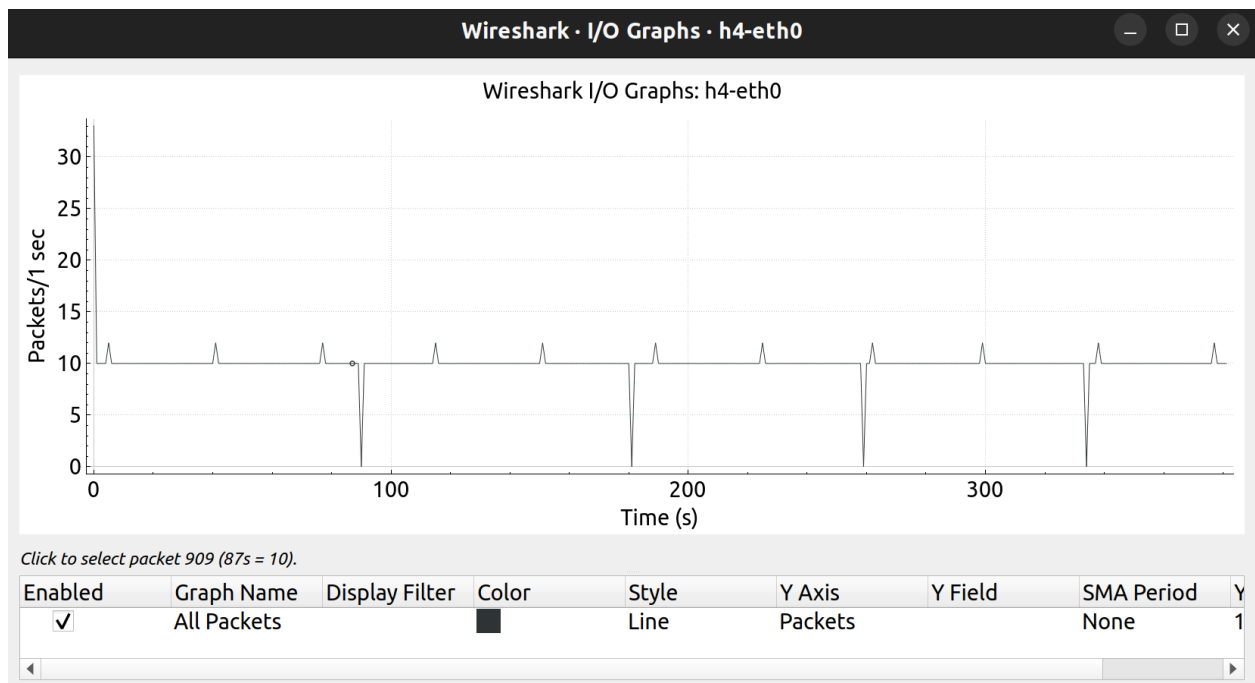
H1 (Client Side)



Packets/sec sent vs Time plot for client side

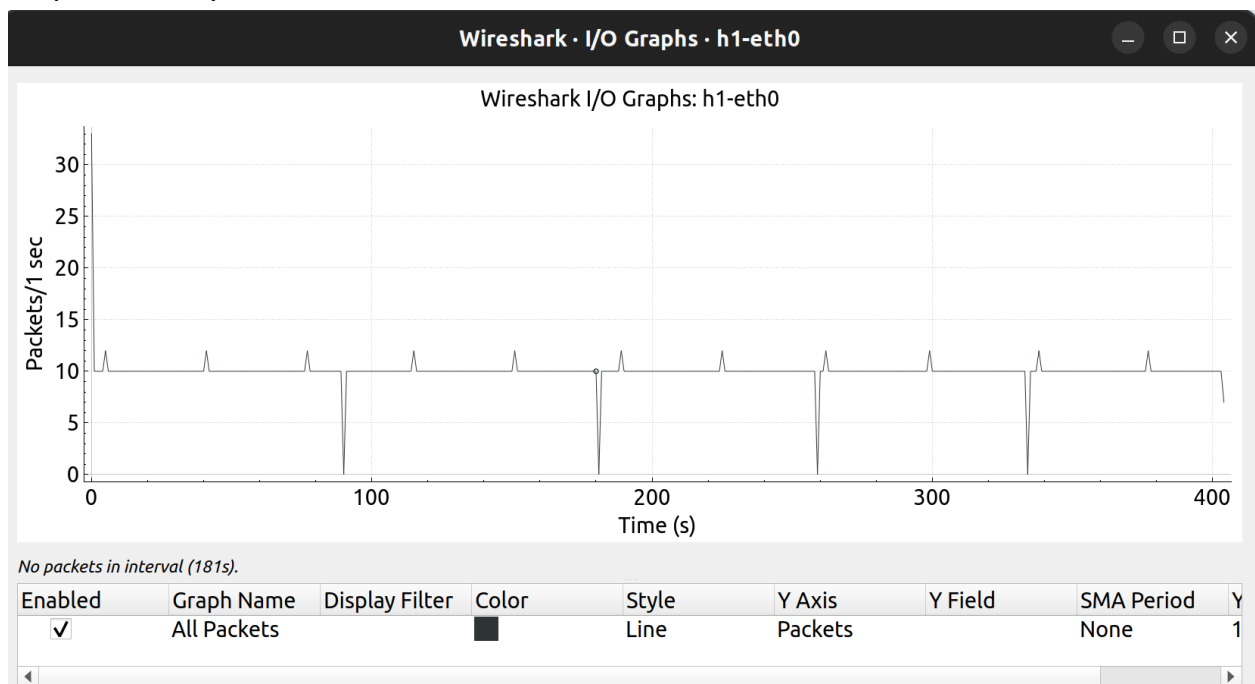
Congestion=BBR

H4 (Server Side)



Packets/sec received vs Time plot for server side

H1 (Client Side)



Packets/sec sent vs Time plot for client side

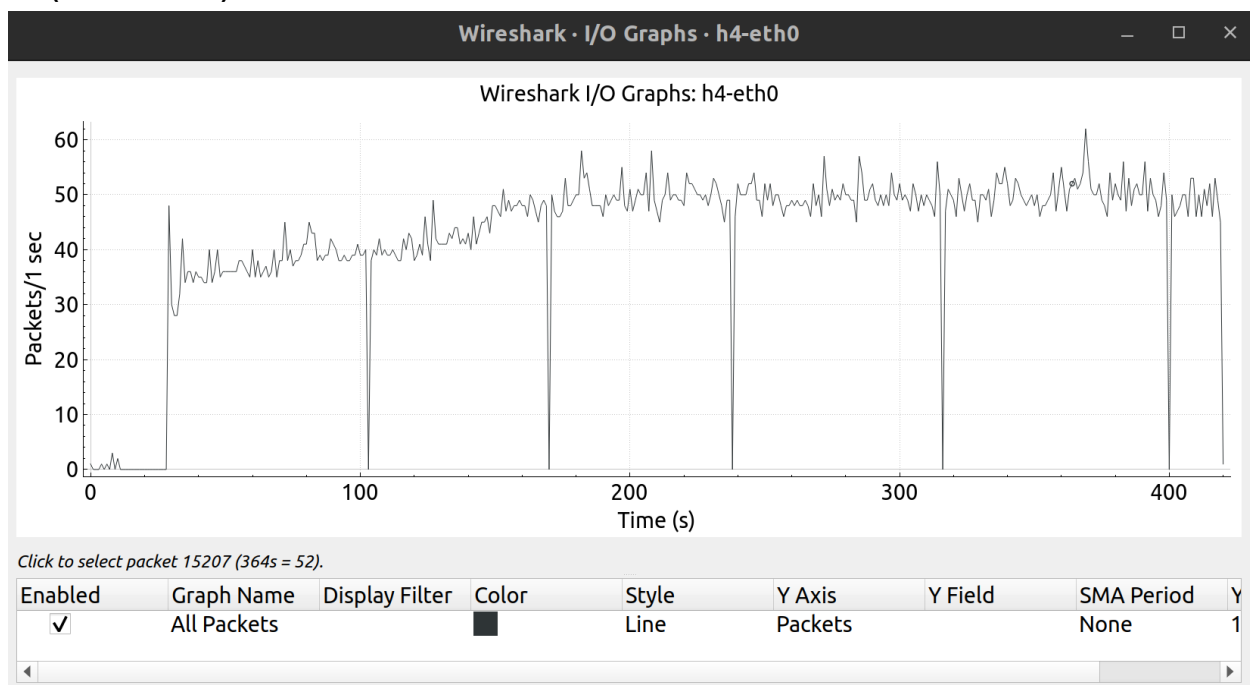
Part (b) Result: From all the plots that we can see, Vegas congestion control scheme has offered the highest throughput rate whereas the BBR congestion control scheme has offered the least throughput rate. However, the packet transfer rate has remained relatively conservative for reno congestion control scheme when compared to others whereas cubic has been relatively aggressive.

(c)

(d) Throughput for various congestion control schemes (Vegas, Reno, Cubic, BBR) but with link loss of 1% and 3% (Config=b for all of the following throughputs) (link loss to be changed in custom topology script)

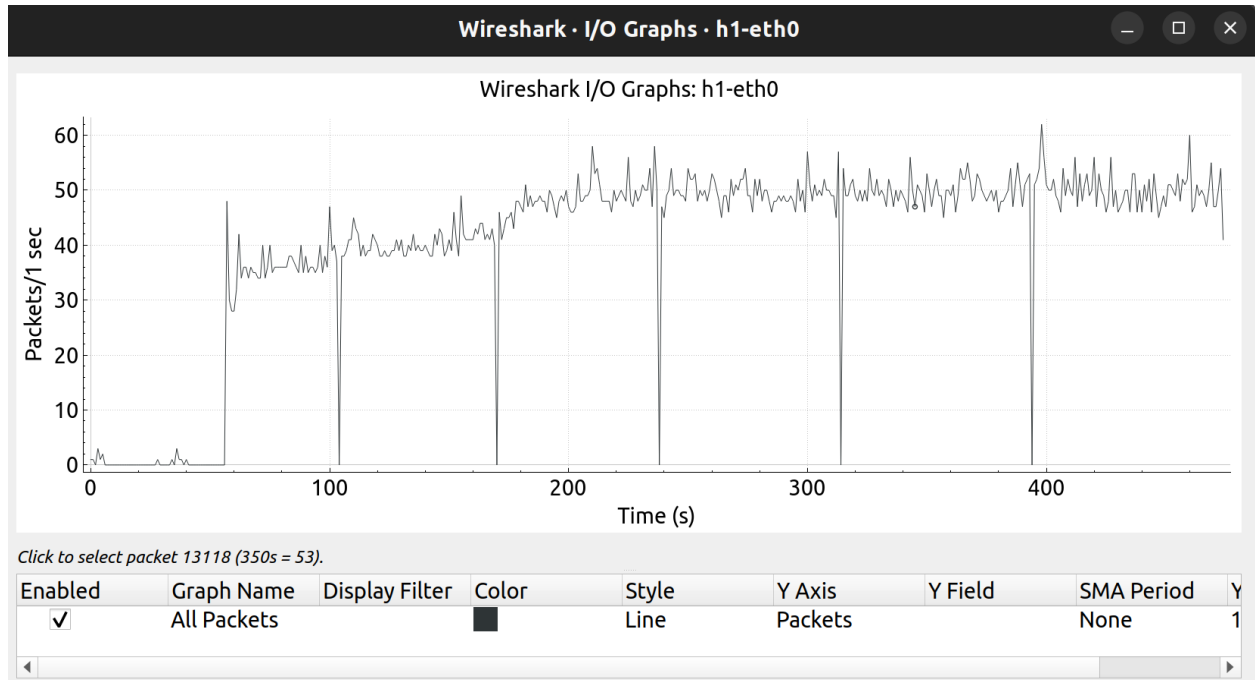
Congestion=Vegas, loss=1%

H4 (Server Side)



Packets/sec received vs Time plot for server side

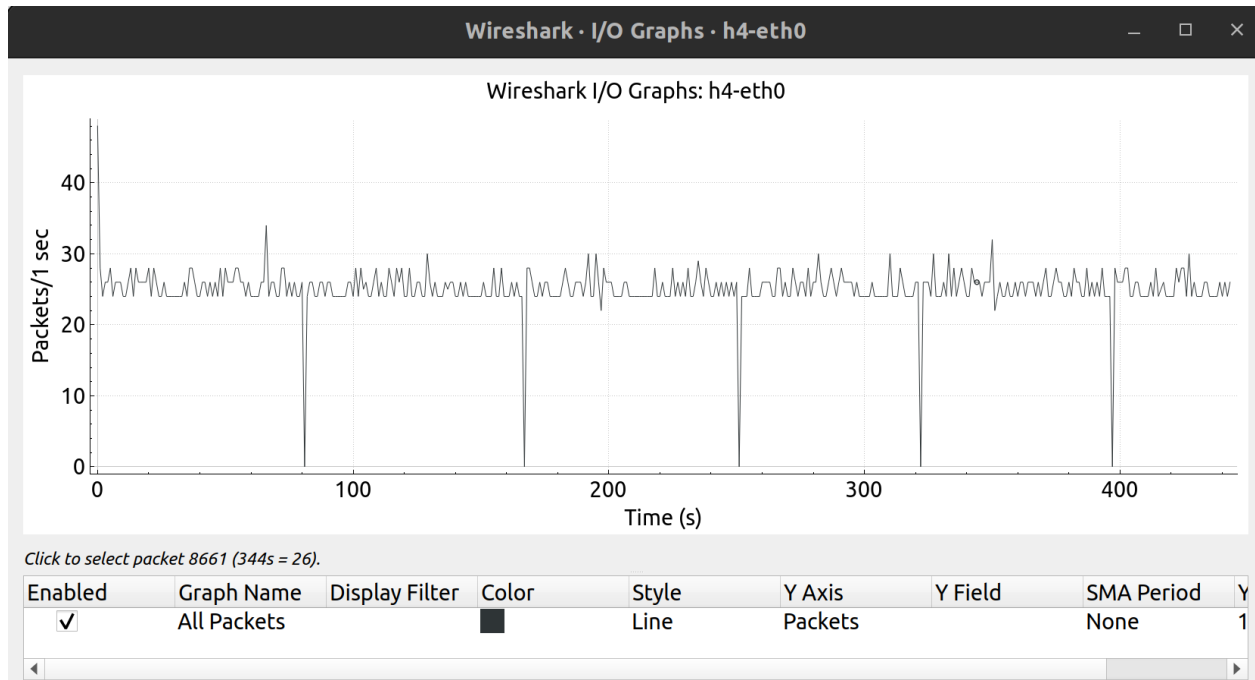
H1 (Client Side)



Packets/sec sent vs Time plot for client side

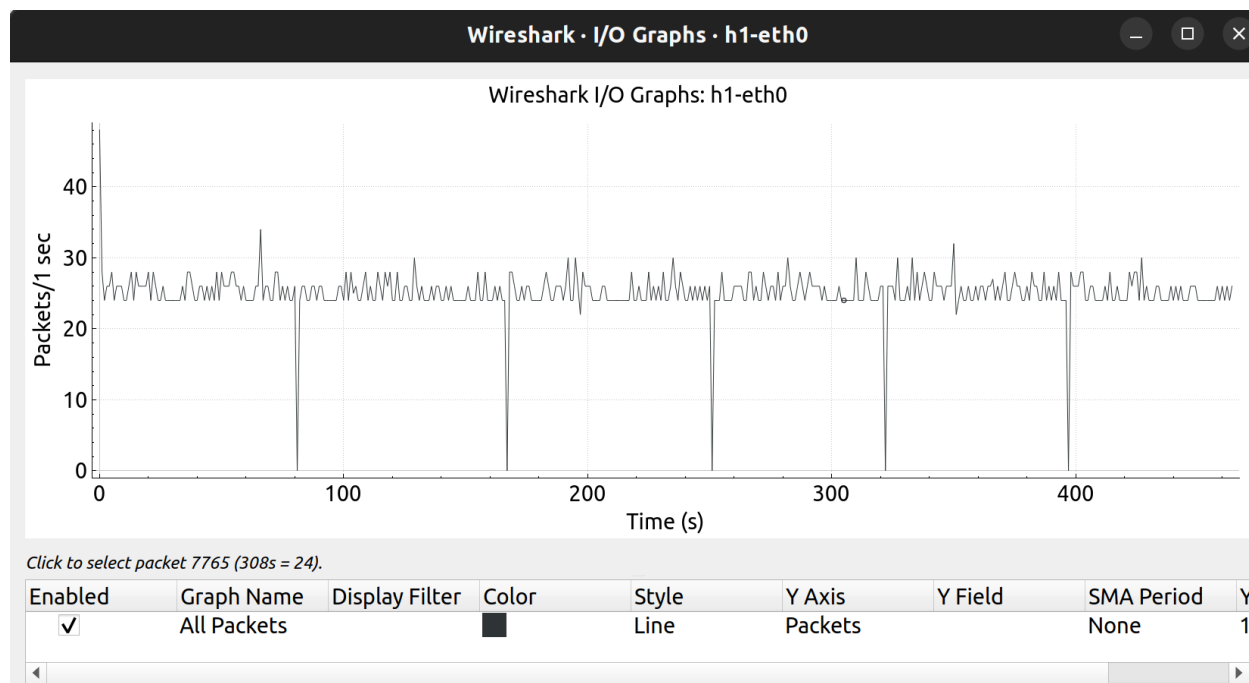
Congestion=Reno, loss=1%

H4 (Server Side)



Packets/sec received vs Time plot for server side

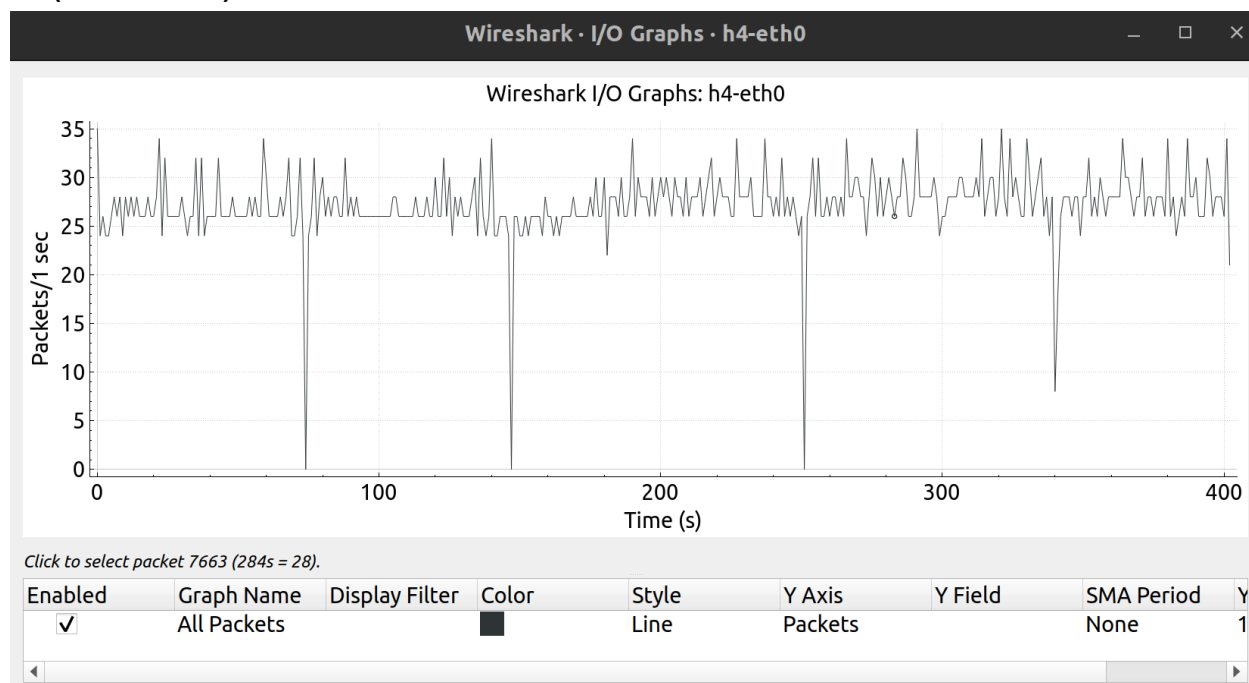
H1 (Client Side)



Packets/sec sent vs Time plot for client side

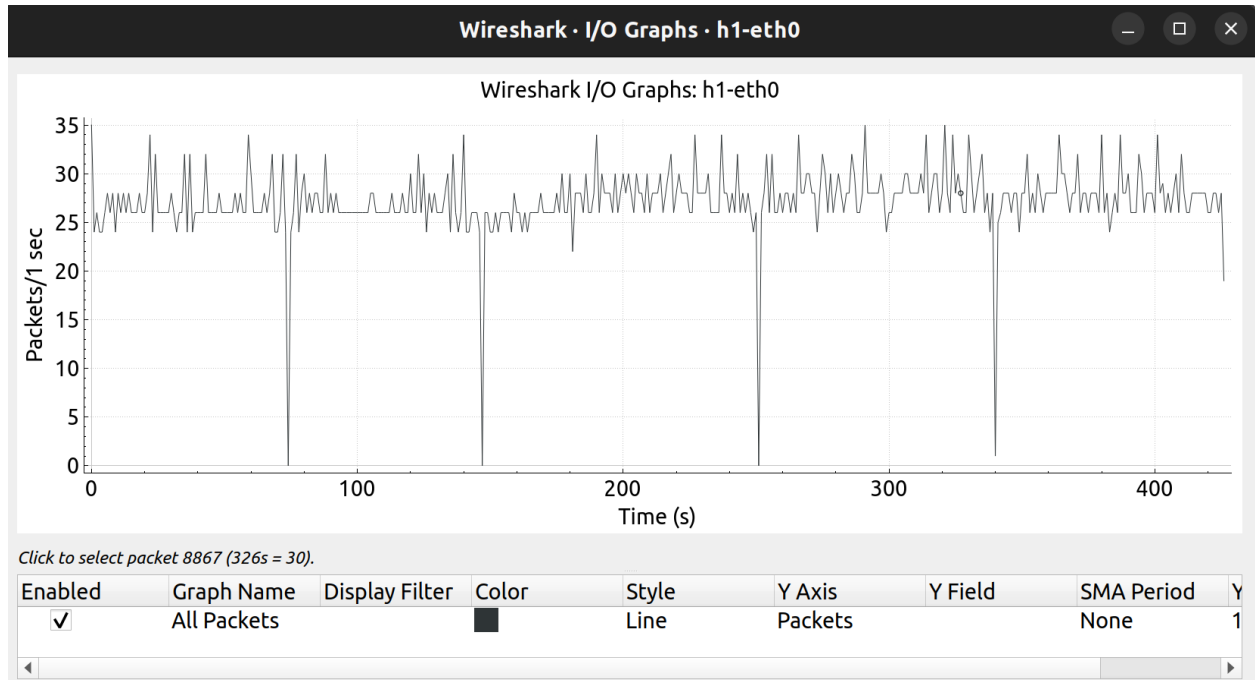
Congestion=Cubic, loss=1%

H4 (Server Side)



Packets/sec received vs Time plot for server side

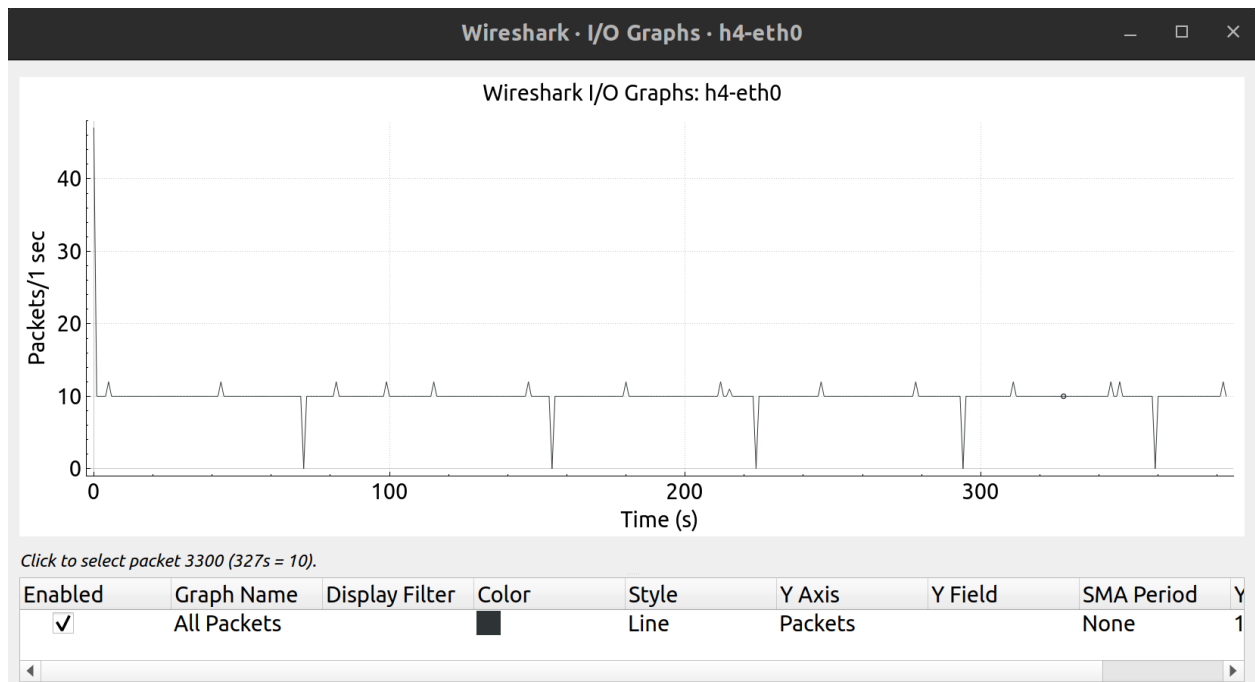
H1 (Client Side)



Packets/sec sent vs Time plot for client side

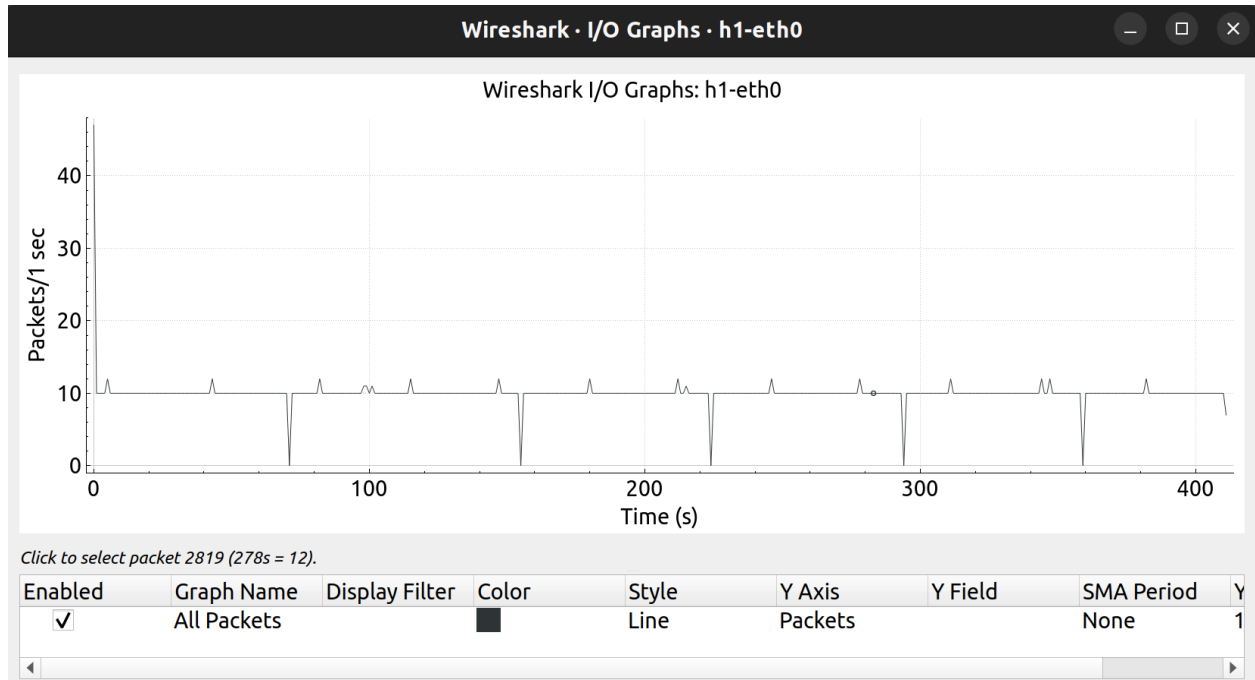
Congestion=BBR, loss=1%

H4 (Server Side)



Packets/sec received vs Time plot for server side

H1 (Client Side)

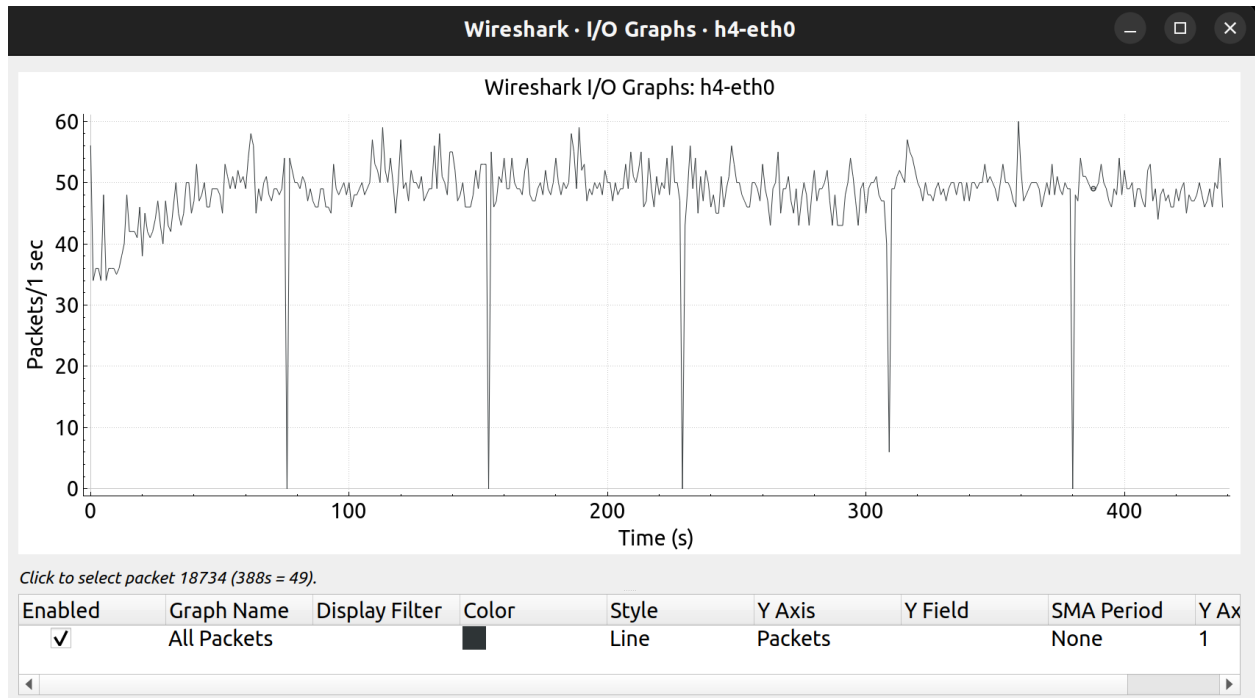


Packets/sec sent vs Time plot for client side

Result (d (loss=1%)): The overall observations are somewhat similar to what we observed in part (b), however, 1% link loss between the switches has caused more inconsistent throughput rates, i.e. more frequent fluctuations, is higher for all 4 congestion control schemes. This is because lost packets are supposed to be retransmitted which causes a more dynamicity in send rates.

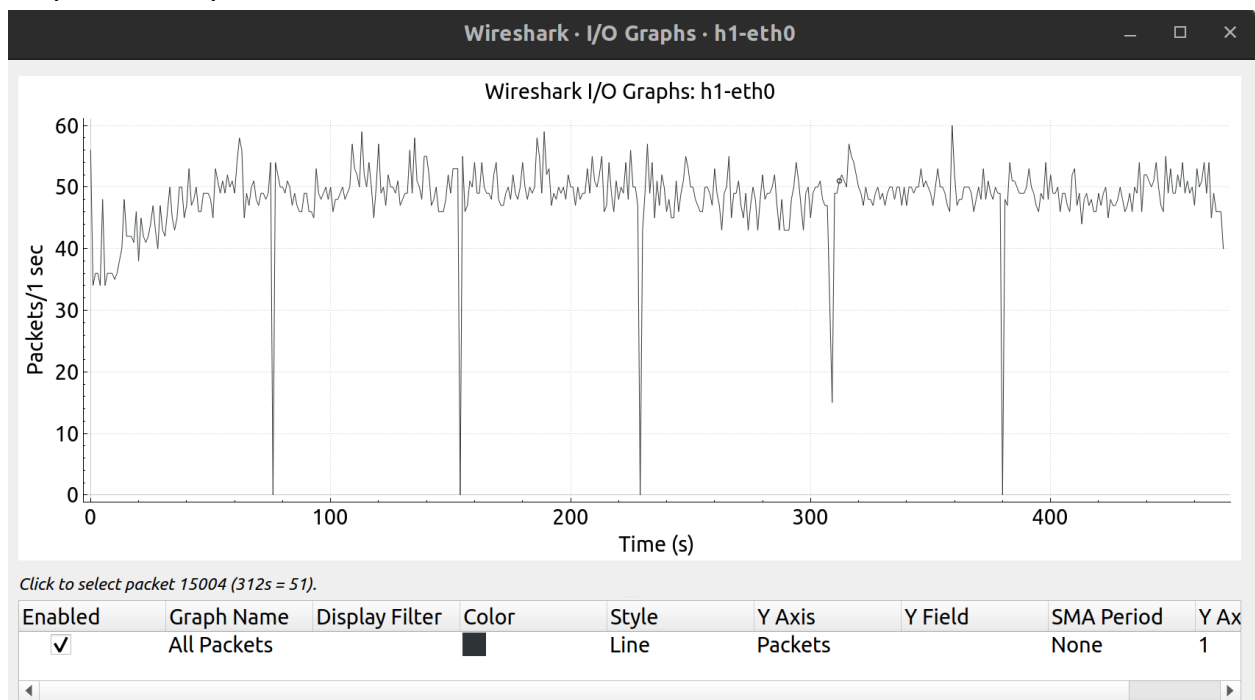
Congestion=Vegas, loss=3%

H4 (Server Side)



Packets/sec received vs Time plot for server side

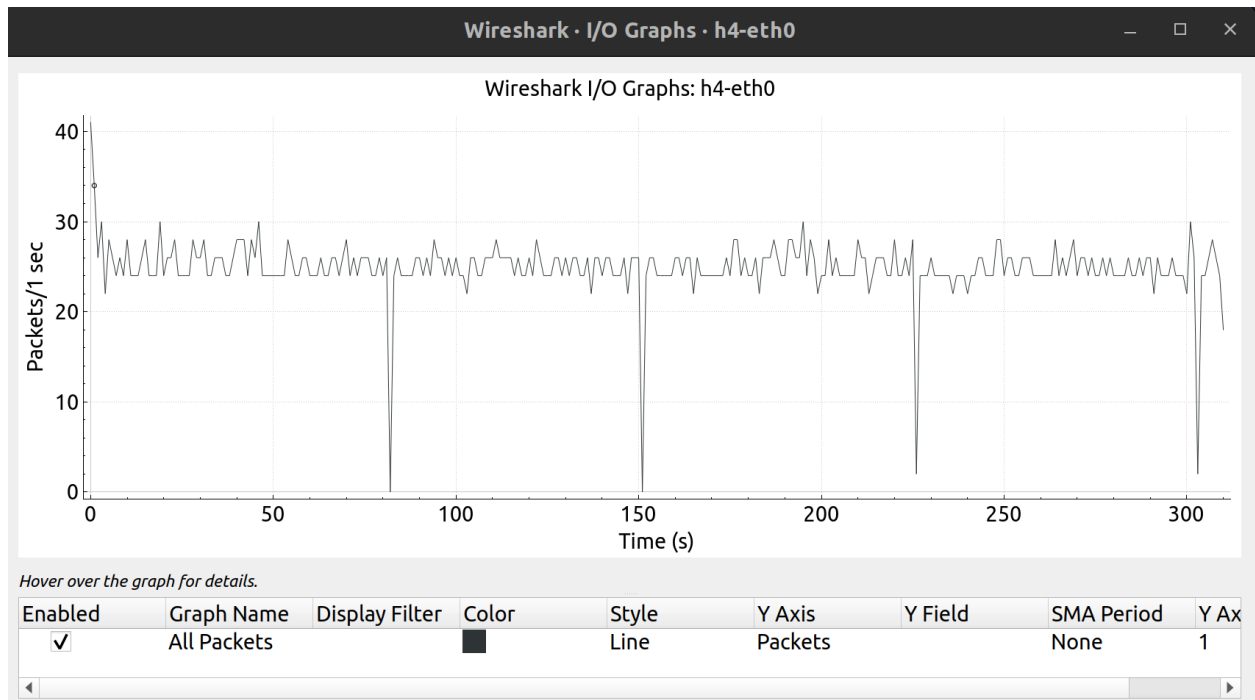
H1 (Client Side)



Packets/sec sent vs Time plot for client side

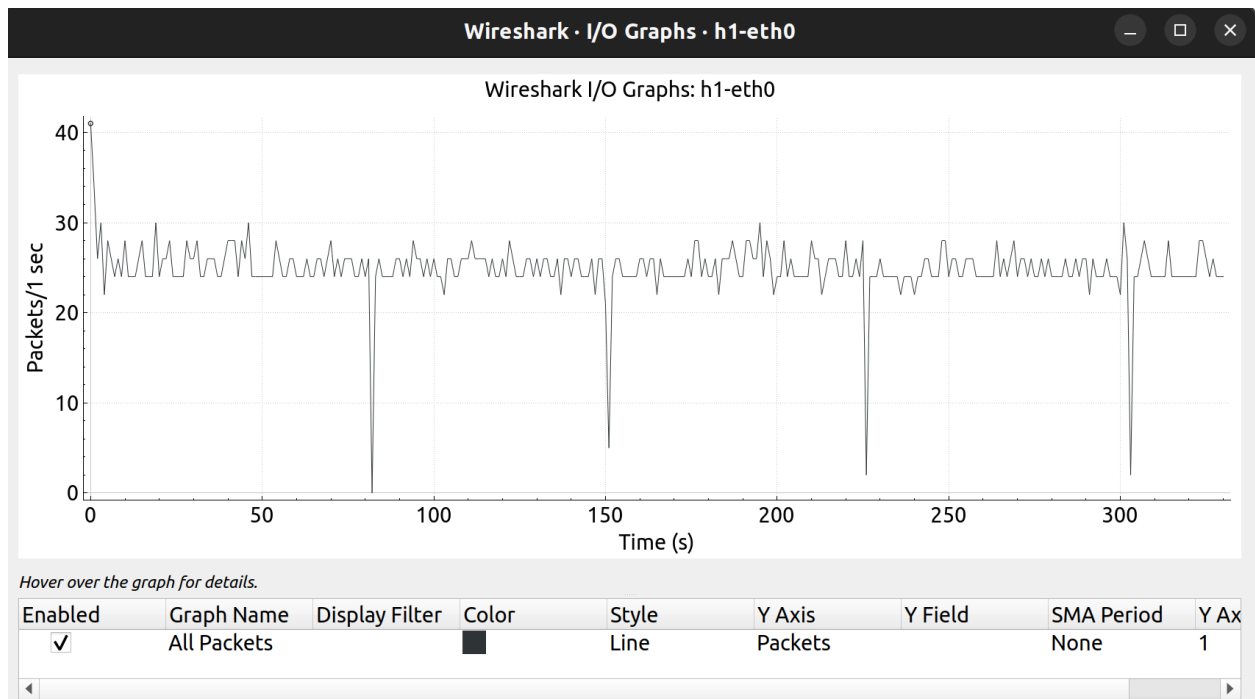
Congestion=Reno, loss=3%

H4 (Server Side)



Packets/sec received vs Time plot for server side

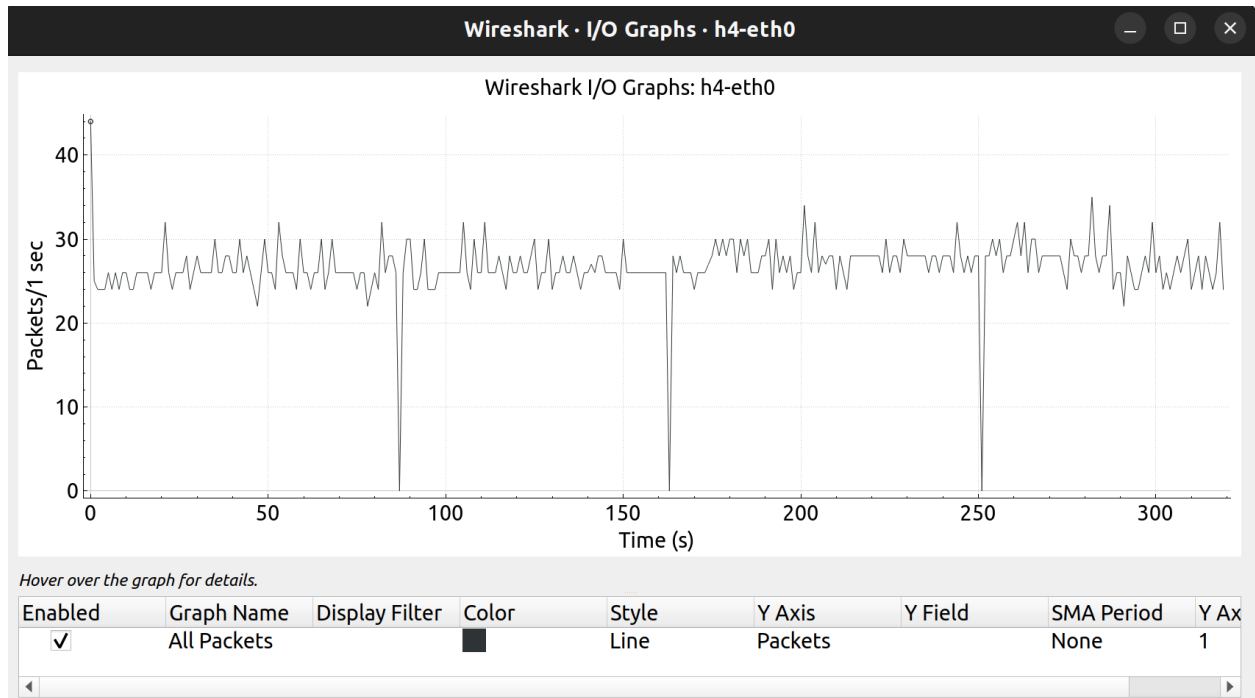
H1 (Client Side)



Packets/sec sent vs Time plot for client side

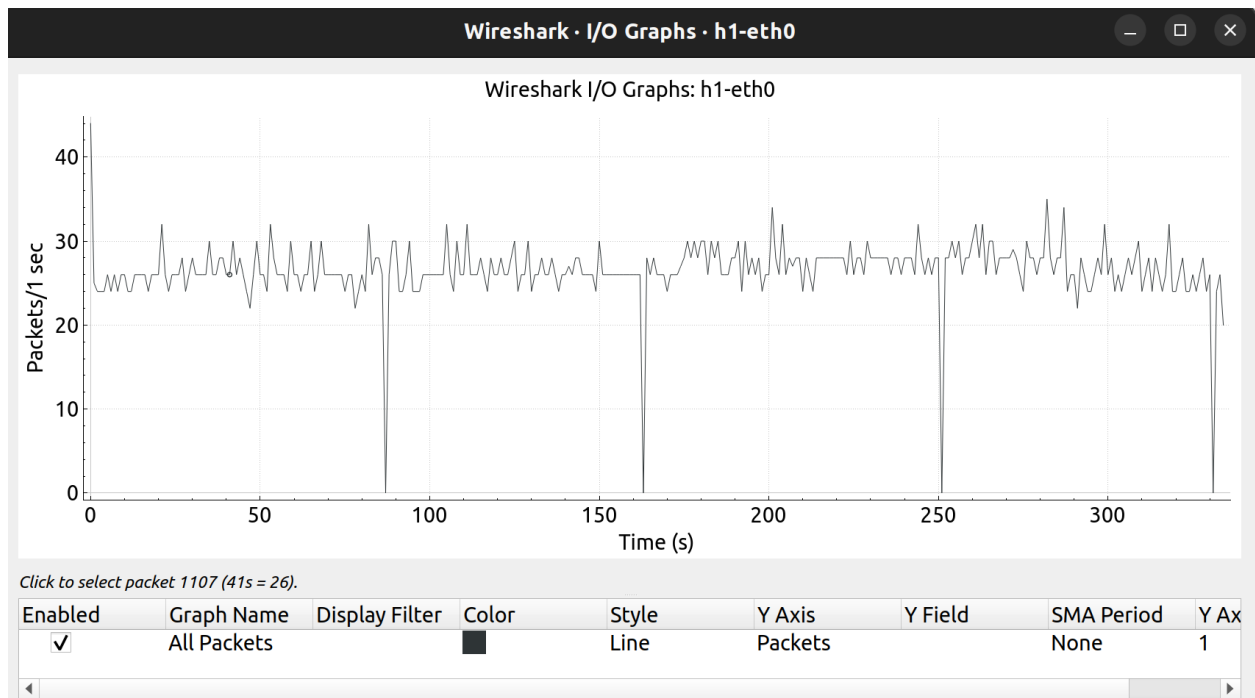
Congestion=Cubic, loss=3%

H4 (Server Side)



Packets/sec received vs Time plot for server side

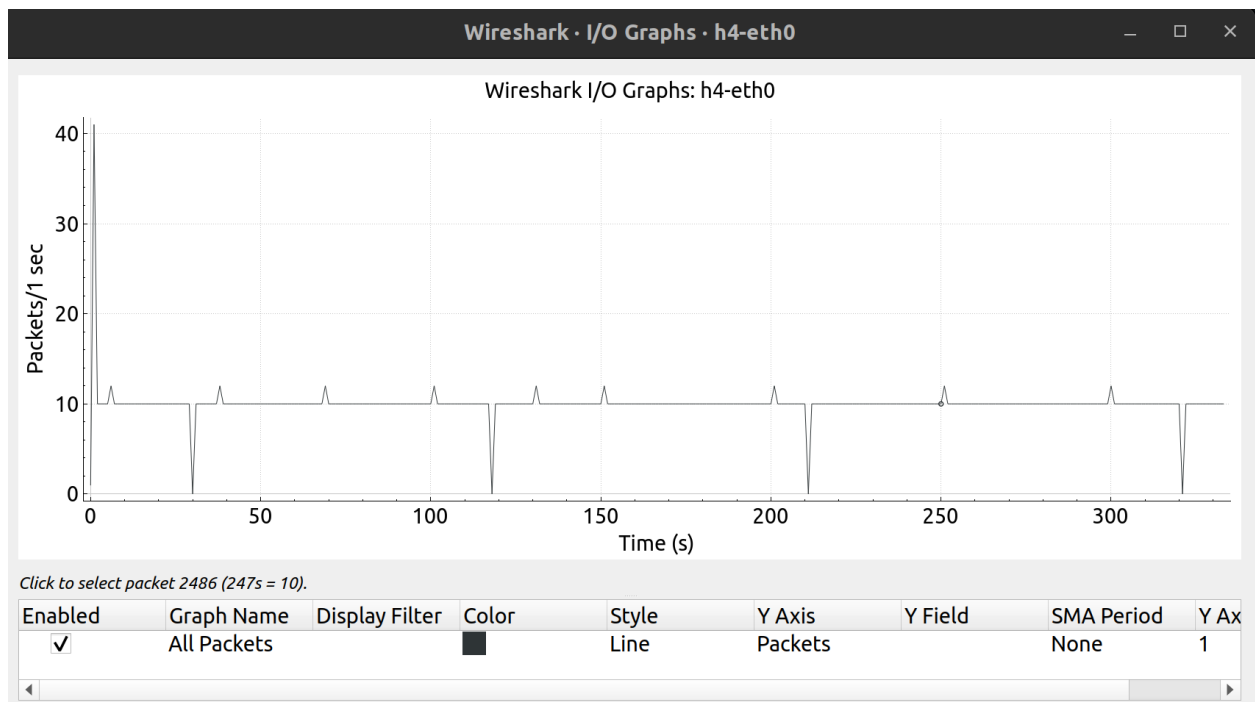
H1 (Client Side)



Packets/sec sent vs Time plot for client side

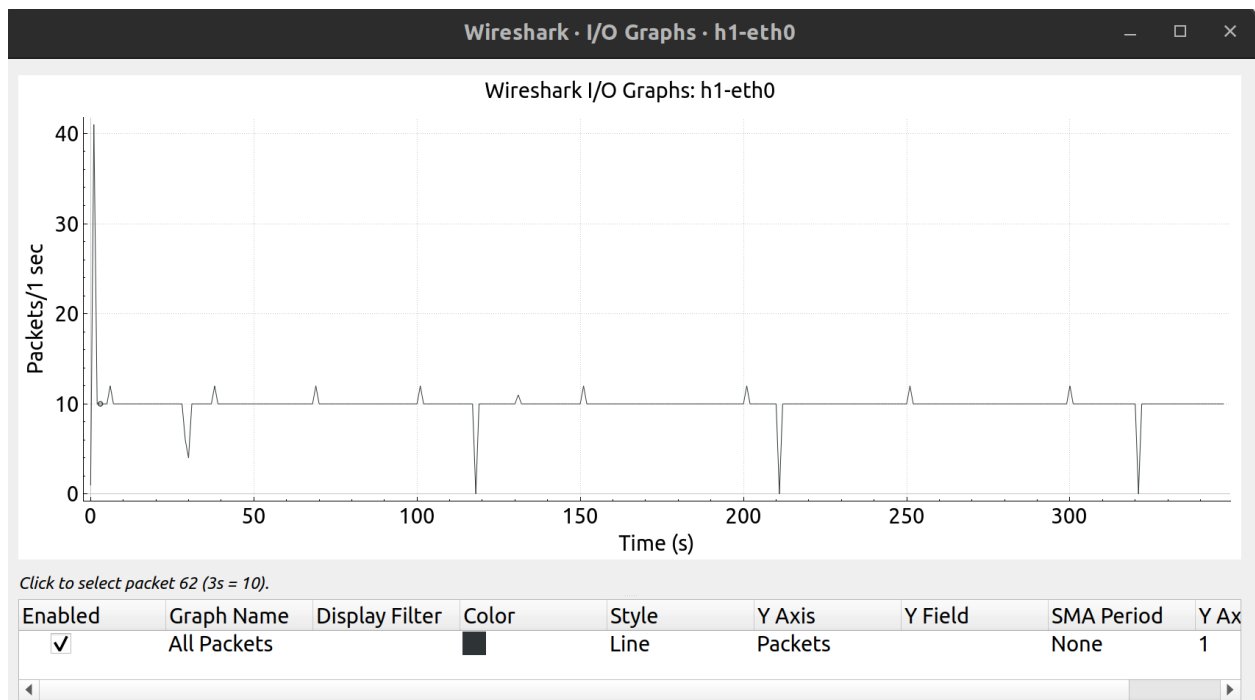
Congestion=BBR, loss=3%

H4 (Server Side)



Packets/sec received vs Time plot for server side

H1 (Client Side)



Packets/sec sent vs Time plot for client side