1. What is the normal time required to download the webpage on h1 from h2?
   ~ 1 second

2. What was your initial expectation for the congestion window size over time?
   Initially when the connection starts, it is in the slow start state of congestion control, so there is an exponential increase i.e., cwnd doubles with each RTT. Once the cwnd exceeds ssthresh, it moves to the congestion avoidance state where cwnd increases linearly every RTT.

3. After starting iperf on h1, did you observe something interesting in the ping RTT?
   Ping RTT increases after starting iperf.
   Without iperf, average ping RTT is 38ms for 10 packets.
   With iperf running, average ping RTT is 700ms for 10 packets.

4. After starting iperf on h1, why does the web page take so much longer to download?
   The webpage now takes 6 seconds to download. Since iperf tests throughput by generating traffic, the bandwidth is now shared between the download process and iperf i.e., share the router queues with the iperf flow traffic. The packets for the web flow are delayed behind the iperf packets leading to increased queueing delays. This in turn increases the total delay for the web download

5. Please provide the figures for the first experiment (with qlen 100).
   a. * Please comment on what you can see in the figures.

TCP congestion window (cwnd) timeseries

TCP congestion window (cwnd) timeseries
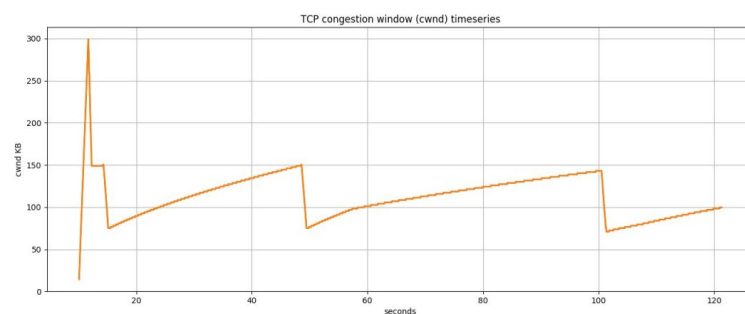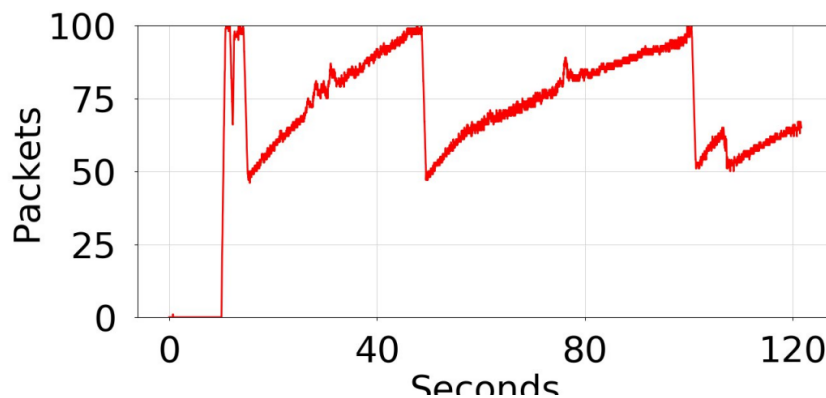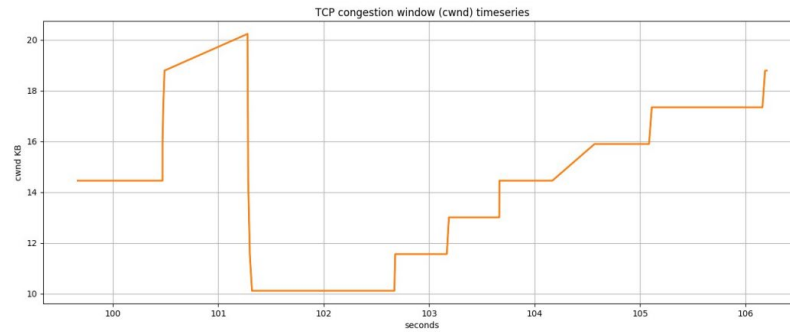
The initial slow start phase eventually leads to a congestion event around ~12 seconds. This is reflected by the router buffer queue being full (i.e, 100 packets which is the buffer size). There seems to be another congestion event around 16 seconds, at which the buffer queue is maximum and the cwnd is cut by half. Following this, the flow enters congestion avoidance for the rest of the duration and we can see the additive increase followed by multiplicative decrease. The value of cwnd peaks to 150kB (from the second figure) before reducing by half

6. Please provide the figures for the second experiment (with qlen 20).
   a. * Please comment on what you can see in the figures and what is different from the previous experiment. Explain the reason behind the difference.

TCP congestion window (cwnd) timeseries

TCP congestion window (cwnd) timeseries
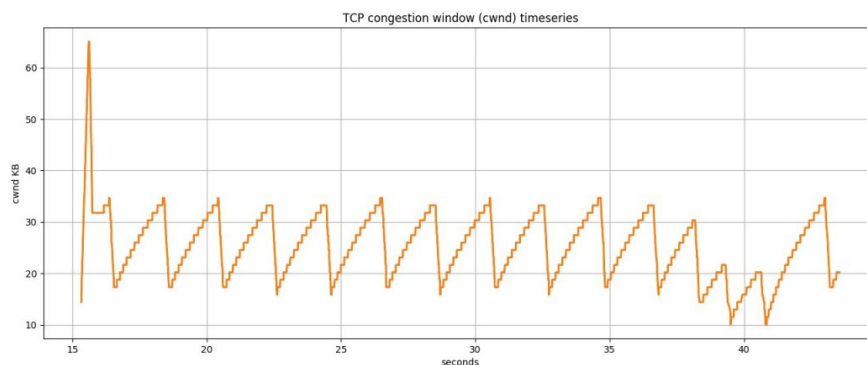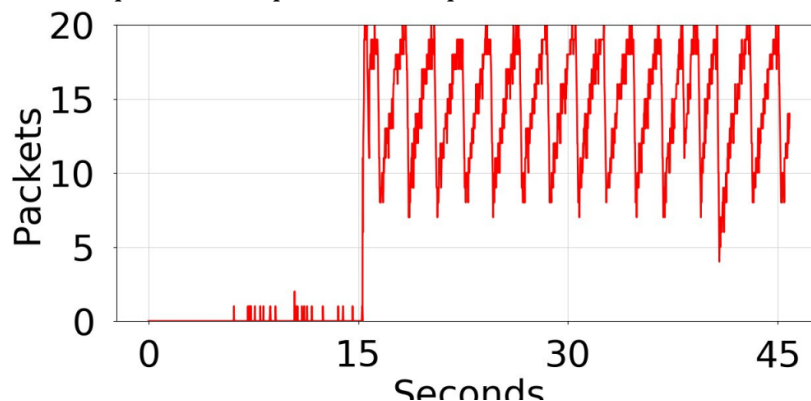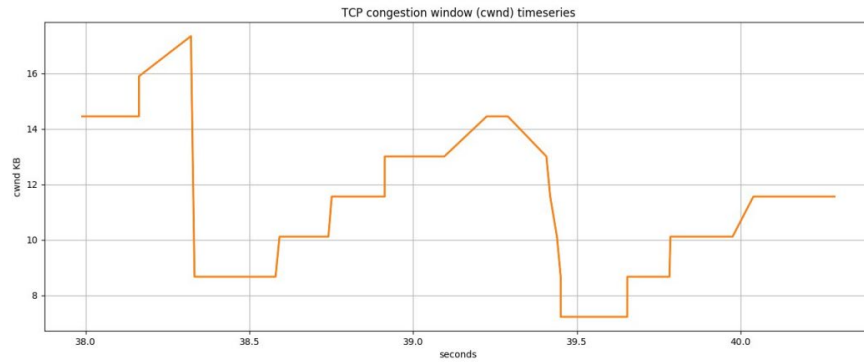
The webpage now only takes 3 seconds to download. This is shorter than the previous experiment. The wget packets still share this short buffer with the iperf flow but queueing delay is shorter due to the reduced size of the buffer.
The cwnd behaviour is similar to previous experiment but its size is smaller. The initial slow start phase eventually leads to a congestion event faster than in previous case since router buffer queue (of size 20 packets) fills faster. The value of cwnd peaks to 32kB before reducing by half.