

What is the normal time required to download the webpage on h1 from h2?

```
mininet> h2 wget h1
--2023-03-07 20:56:13-- http://10.0.0.1/
Connecting to 10.0.0.1:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 177669 (174K) [text/html]
Saving to: 'index.html'

 0K ..... 28% 159K 1s
50K ..... 57% 154K 0s
100K ..... 86% 159K 0s
Terminal ..... 100% 186K=1.1s

2023-03-07 20:56:14 (161 KB/s) - 'index.html' saved [177669/177669]
```

1.1s

What was your initial expectation for the congestion window size over time?

The cwnd should increase faster and faster. After a long time it is expected to stop increasing to avoid congestion.

After starting iperf on h1, did you observe something interesting in the ping RTT?
ping **without** iperf:

```
mininet> h1 ping -c 10 h2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=44.6 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=31.0 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=51.5 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=39.7 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=44.2 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=30.9 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=41.7 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=31.3 ms
64 bytes from 10.0.0.2: icmp_seq=9 ttl=64 time=41.9 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=42.4 ms

--- 10.0.0.2 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9016ms
rtt min/avg/max/mdev = 30.982/39.973/51.517/6.490 ms
```

ping **with** iperf:

```

mininet> h1 ./iperf.sh
started iperf
mininet> h1 ping -c 10 h2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=614 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=825 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=853 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=460 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=492 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=472 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=504 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=524 ms
64 bytes from 10.0.0.2: icmp_seq=9 ttl=64 time=530 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=548 ms

--- 10.0.0.2 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9037ms
rtt min/avg/max/mdev = 460.406/582.551/853.134/134.746 ms

```

RTT is increased after iperf is started.

After starting iperf on h1, why does the web page take so much longer to download?

```

mininet> h2 wget h1
--2023-03-07 21:06:15-- http://10.0.0.1/
Connecting to 10.0.0.1:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 177669 (174K) [text/html]
Saving to: 'index.html.5'

 0K ..... 28% 13.5K 9s
50K ..... 57% 24.7K 4s
100K ..... 86% 29.6K 1s
150K ..... 100% 37.0K=8.1s

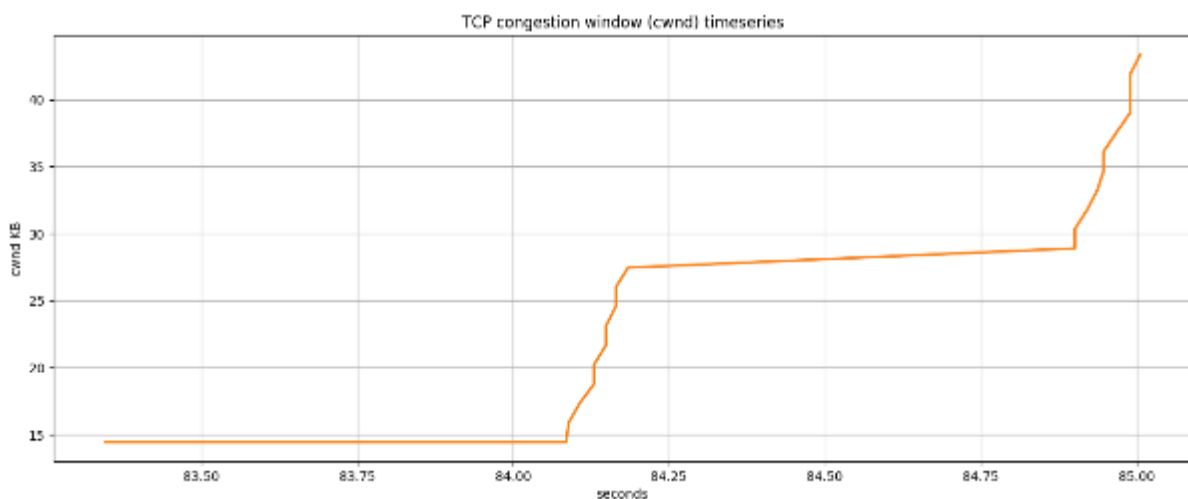
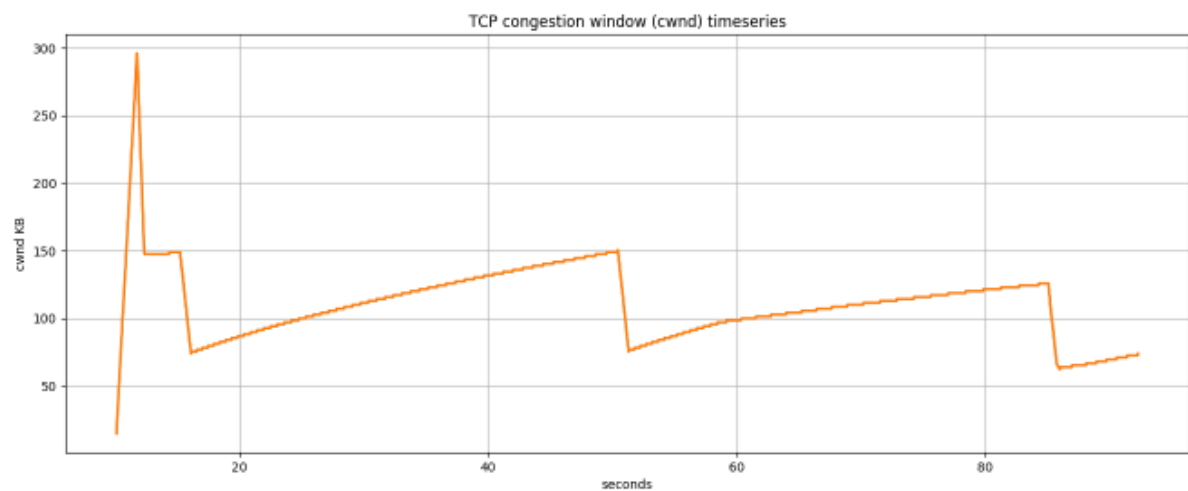
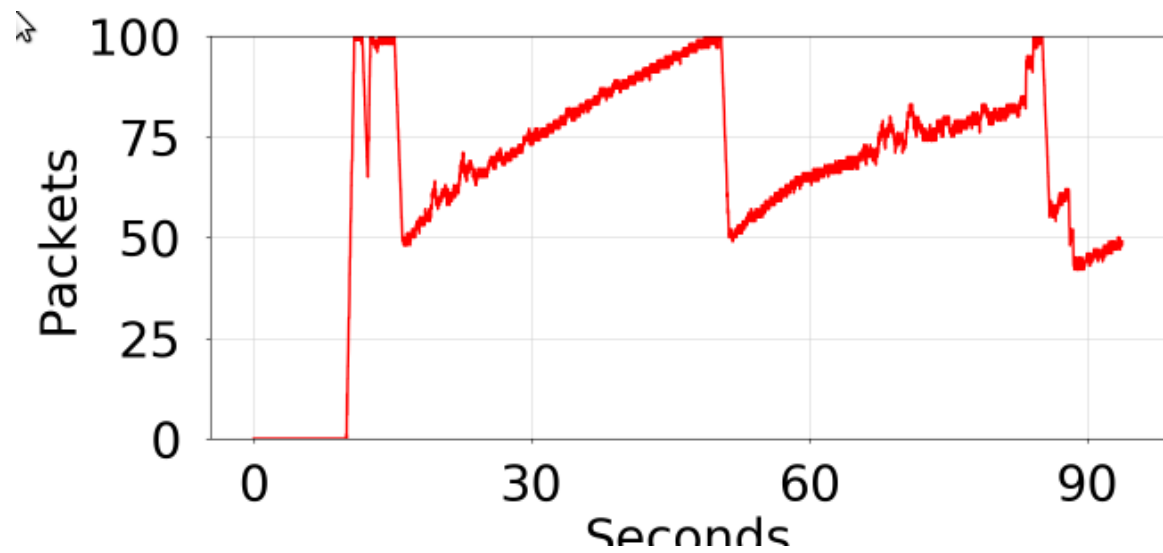
2023-03-07 21:06:25 (21.5 KB/s) - 'index.html.5' saved [177669/177669]

```

because the network is used by iperf, while it was used only by the download itself before.

Please provide the figures for the first experiment (with qlen 100).

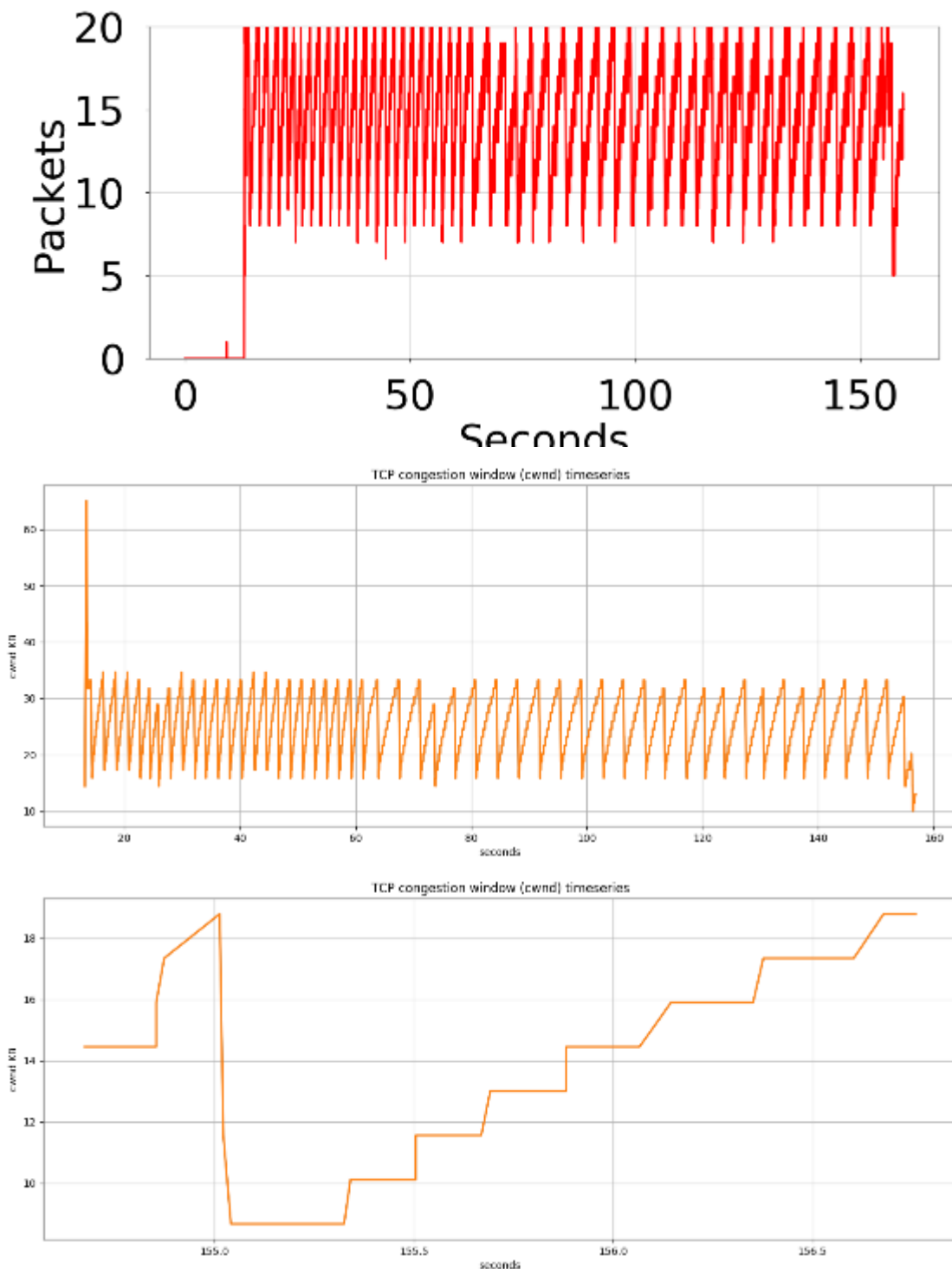
* Please comment on what you can see in the figures.



comment: The packet number is halved when it reaches 100 which is the buffer size. The buffer is filled very slowly. The download of the webpage takes a long time. The cwnd for it is increasing very slowly.

Please provide the figures for the second experiment (with qlen 20).

* Please comment on what you can see in the figures and what is different from the previous experiment. Explain the reason behind the difference.



comment: The buffer is filled much faster. This can lead to a better performance of the webpage download.

Reason of difference: As the buffer is smaller, it can be filled faster and cwnd decreases more frequently than experiment 1. When the download starts at about 150s, cwnd for iperf

does not reach the same peak anymore. The cwnd for download reaches the peak very quickly, and is halved, and starts increasing again.