What is Bufferbloat?

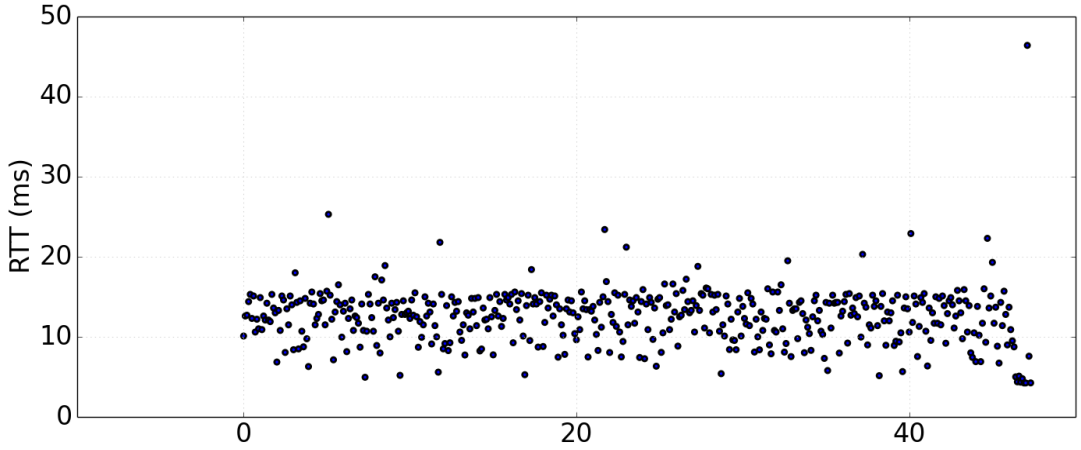
The bufferbloat problem refers to the high latency that occurs due to excess buffering of packets at the bottleneck nodes of a network. A common analogy is that of a highway interrupted by parking lots (buffers). If no one is using the parking lot, cars (packets) can simply drive through. If there is a lot of traffic however, cars are stuck waiting in the parking lot (latency), resulting in jerky, uneven traffic.

Simulation Setup

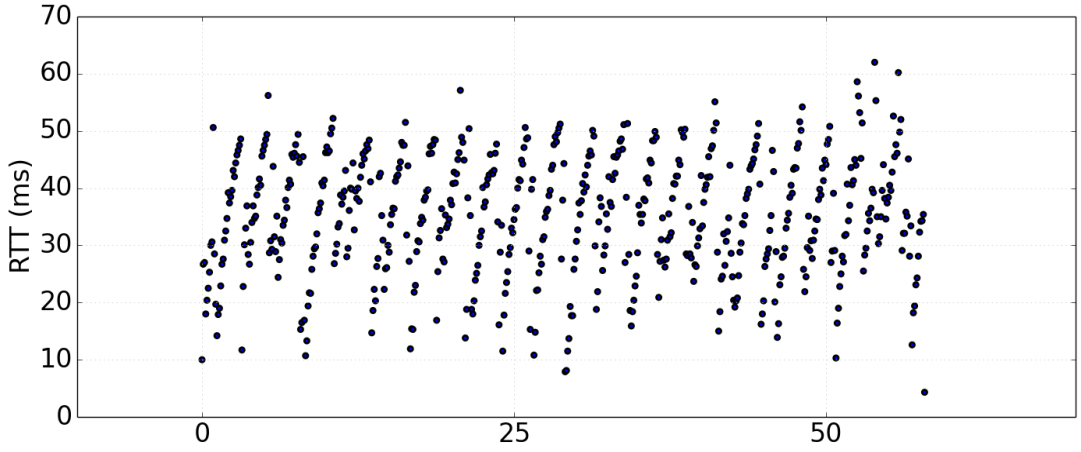
No package installations are required. Simply run “sudo ./run.sh” in the directory containing the run.sh shell script and all the relevant python files.

Round Trip Time (X-axis: time elapsed, Y-axis: RTT)

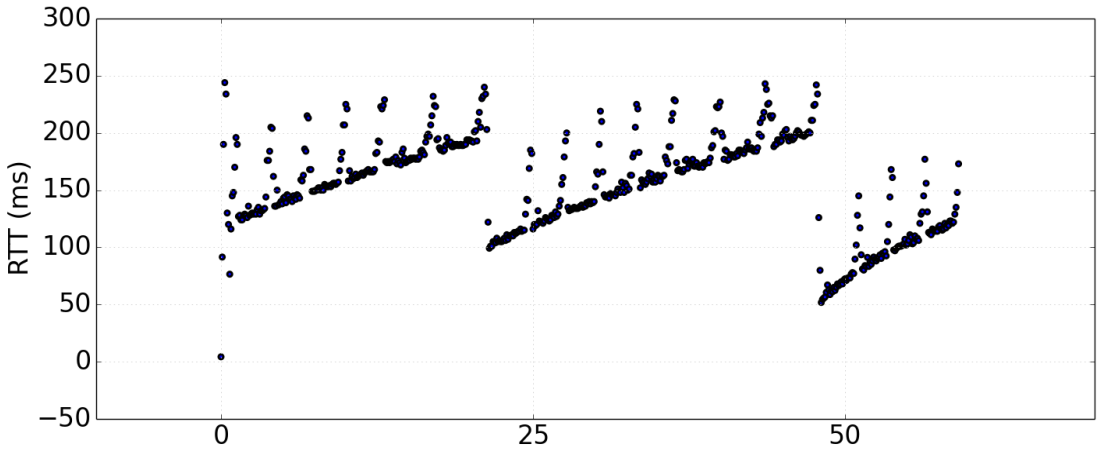
Queue size of 5 packets:



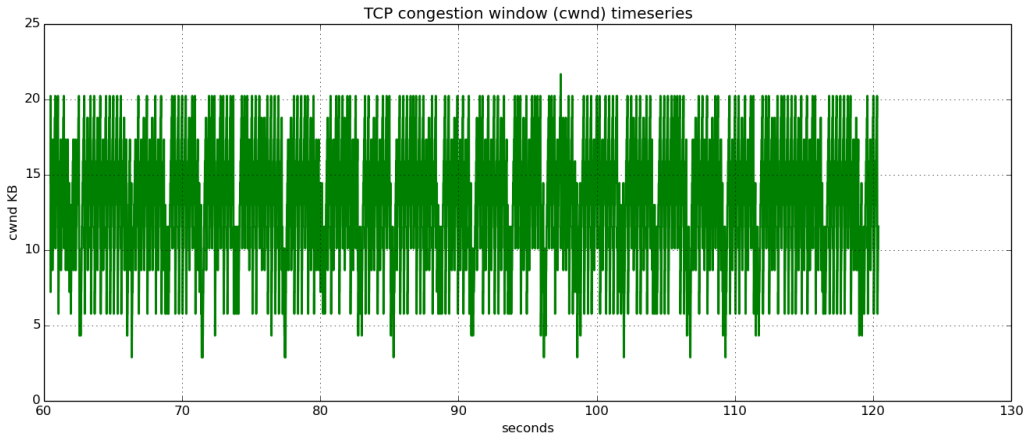
Queue size of 20 packets:



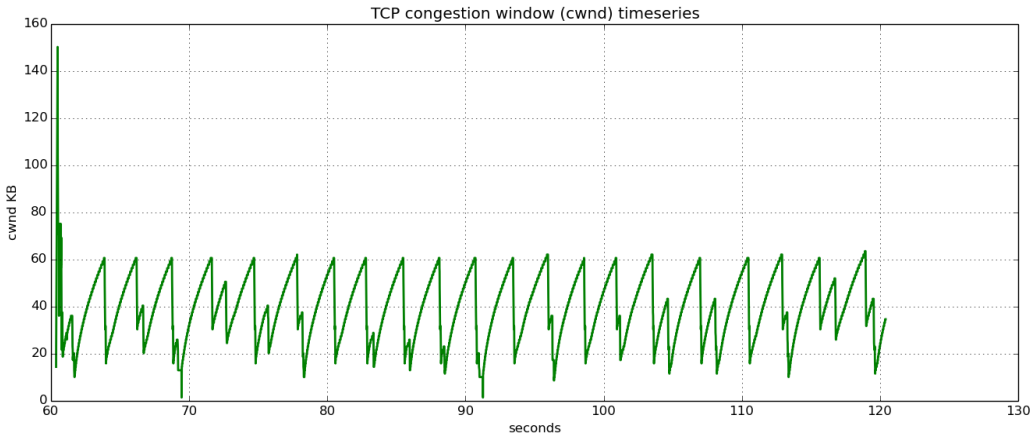
Queue Size of 100 packets:



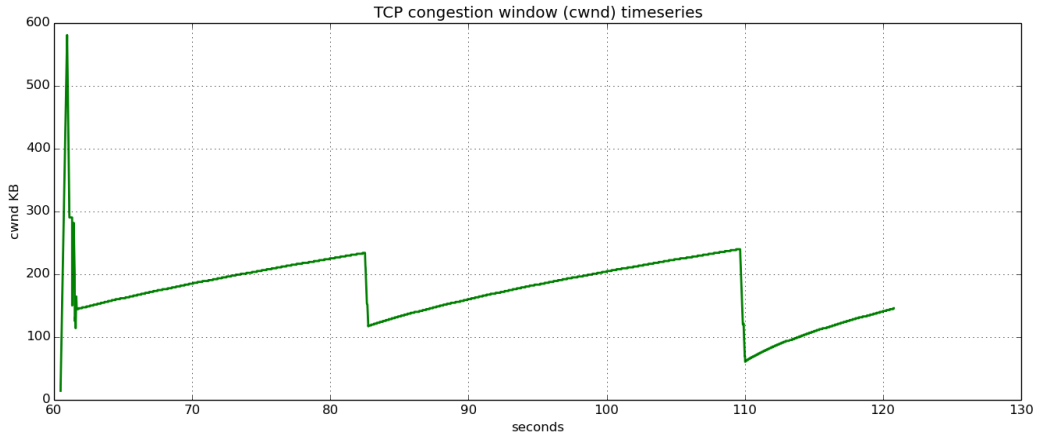
Congestion Window Size (X-axis: time elapsed, Y-axis: Congestion window size (KB))
Queue size of 5 packets:



Queue size of 20 packets:

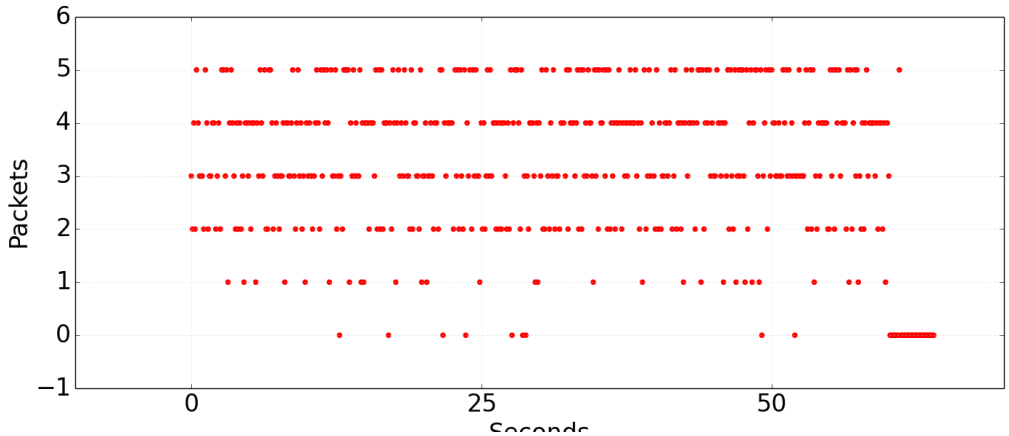


Queue size of 100 packets:

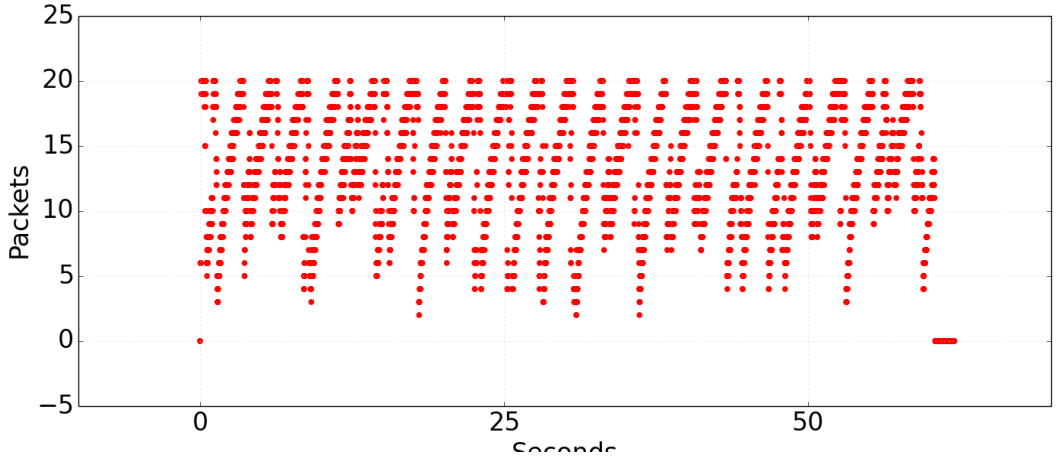


Queue Size At The Router (X-axis: time elapsed, Y-axis: number of packets)

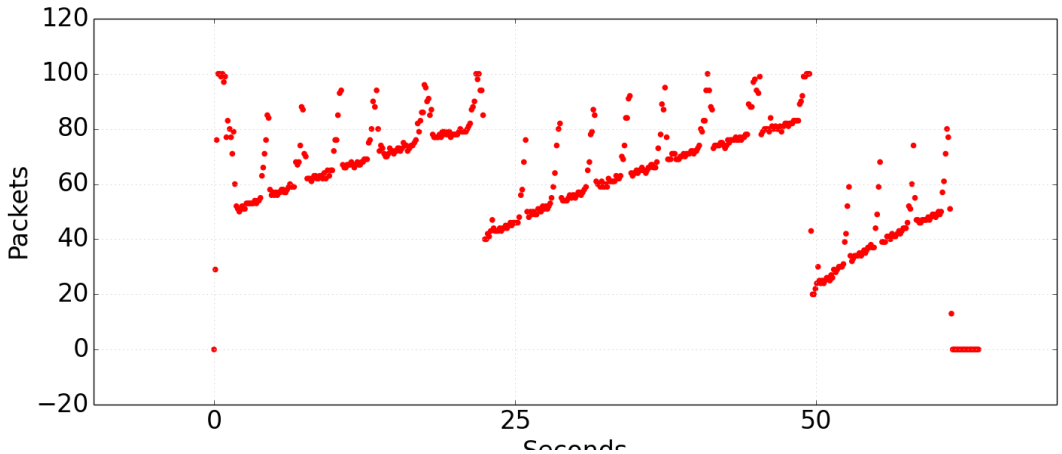
Queue size of 5 packets:



Queue size of 20 packets:

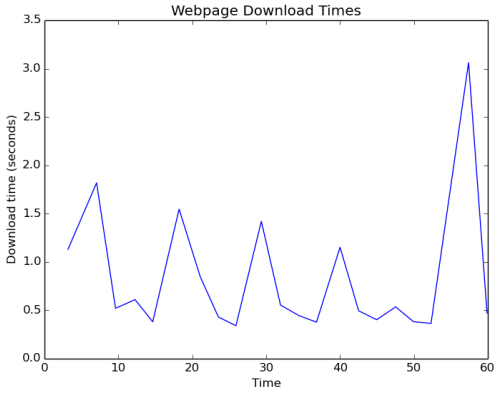


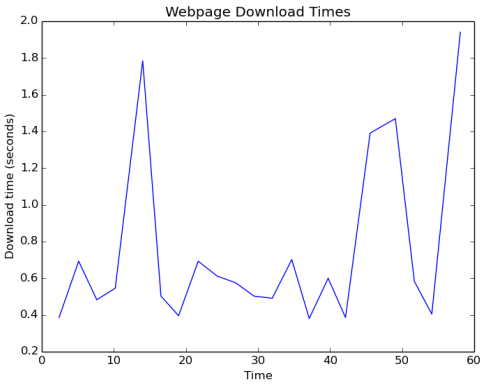
Queue size of 100 packets:

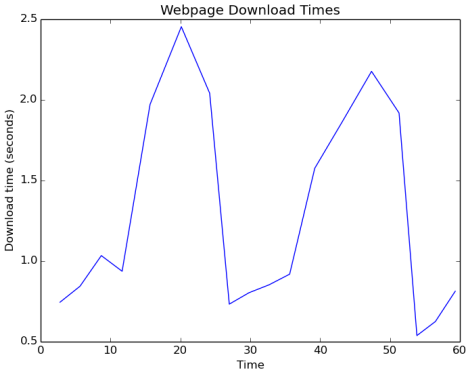


Download Time

Queue size of 5 packets, 20 packets, and 100 packets respectively (left-to-right, top-to-bottom)







1. Why do you see a difference in webpage fetch times with short and large router buffers?

Queue size 20: average=0.739286, standard deviation=0.461516
Queue size 100: average=1.269167, standard deviation=0.612955
We can see that the average fetch time for the short router buffer is shorter than the average fetch time for the longer router buffer. This is likely because a shorter buffer means a shorter queue, so the packets will have a shorter wait time i.e., faster fetch speed.

2. Bufferbloat can occur in other places such as your network interface card (NIC). Check the output of ifconfig eth0 on your VirtualBox VM. What is the (maximum) transmit queue length on the network interface reported by ifconfig? For this queue size, if you assume the queue drains at 100Mb/s, what is the maximum time a packet might wait in the queue before it leaves the NIC?

From ifconfig, txqueuelen (transmission queue length) is equal to 1000 packets. Each packet is 1500 bytes, so the queue can hold 1 500 0000 bytes. If the queue drains at 100Mb/s, then the maximum time that a packet would have to wait in the queue before it leaves the NIC is

(1000*1500*8) / (100*1 000 000) = 0.12 seconds

3. How does the RTT reported by ping vary with the queue size? Write a symbolic equation to describe the relation between the two (ignore computation overheads in ping that might affect the final result).

Examining the RTT graphs for queue_size=5, 20, 100 packets, one can see that round trip time is directly proportional to queue size. A symbolic equation describing the relation between the two is:

RTT = k*queue_size

4. Identify and describe two ways to mitigate the bufferbloat problem.

One way to mitigate the bufferbloat problem is to decrease the size of unmanaged buffers. This will reduce the delay due to buffering, and decrease the clumping effect on the traffic, at the expense of slightly more packet loss.

Another way to mitigate the bufferbloat problem is to employ smarter rules than First In First Out (FIFO) regarding how a buffer should empty itself. Perhaps a set of rules that can be expected to statistically smooth the network traffic to minimize packet delay variation.

References

Introduction. Introduction - Bufferbloat.net. (n.d.). Retrieved November 29, 2021, from https://www.bufferbloat.net/projects/bloat/wiki/Introduction/.

says:, A. C., & says:, D. N. (n.d.). *Bufferbloat - what is it and why you (or your vendor) should care*. Mushroom Networks. Retrieved November 29, 2021, from https://www.mushroomnetworks.com/blog/bufferbloat-what-is-it-and-why-you-or-your-vendor-should-care/.

Fraser Casey 20th Jul, Casey, F., Sam Skinner 22nd Jul, Skinner, S., Sam Skinner 10th Nov, & Sam Skinner 22nd Sep. (2020, July 23). *Beginner's Guide to bufferbloat - how to fix network lag*. Netduma. Retrieved November 29, 2021, from https://netduma.com/blog/beginners-guide-to-bufferbloat/.