CSE310 Project

TCP Congestion Control Algorithm: BBR vs Cubic

Sunwoo Kim

sunwoo.kim.2@stonybrook.edu

Introductions

- Congestion control is an algorithm used in tcp to prevent overflow of the data in router by controlling the amount of data sent into network.

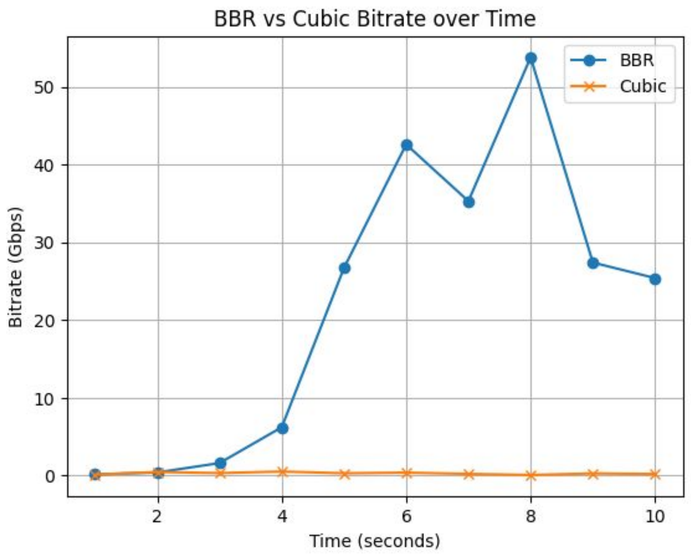
Motivations

- BBR algorithm is estimated to be adopted by approximately 40 percent of internet traffic.
- However, people do not know how it works and when is good to use BBR.

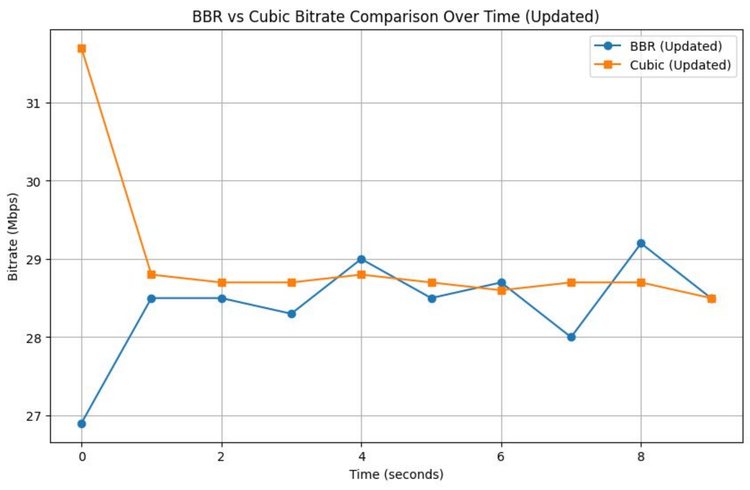
Setups

- Experiment is conducted on LAN networks
- Experiment is conducted using iperf3 to make a tcp connection between two different computers and tc command to control the network environment.

BBR vs Cubic

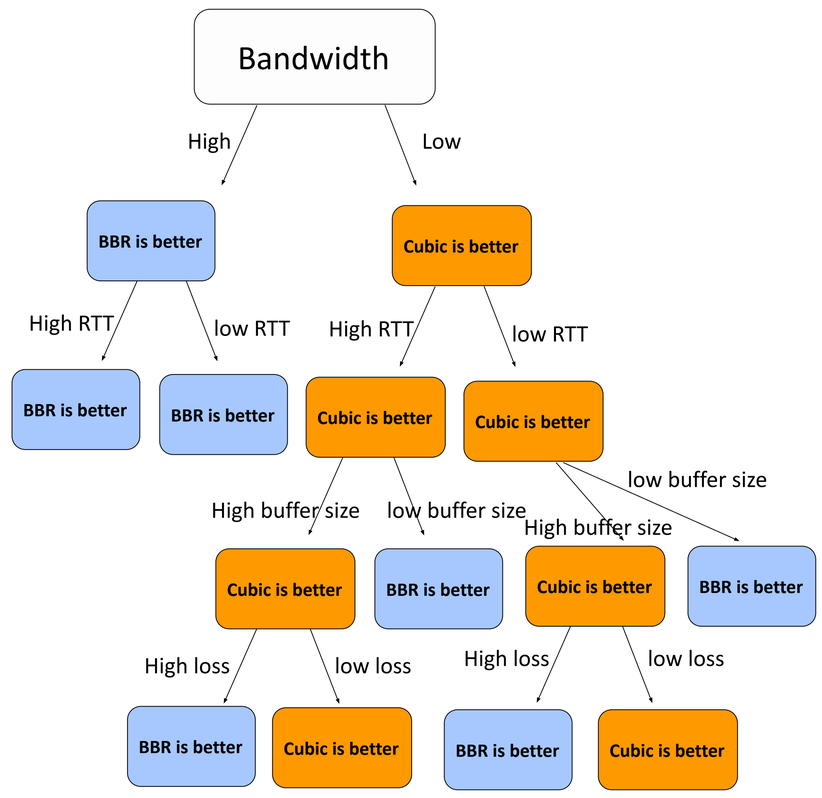


Case where BBR performs better than Cubic



Case where Cubic performs better than BBR

Decision Tree



- Decision Tree tells which algorithm performs better in specific network environment.

Measurement

- Measure the performance of BBR and Cubic in different network environments.

Delay	Buffer size	Loss	Bandwidth	BBR Bitrate	Cubic Bitrate
250ms	100KB	7%	1 Gbps	22.6 Mbps	285 Kbps
250ms	100KB	7%	30 Mbps	13.2 Mbps	483 Kbps
15ms	100KB	0.1%	1 Gbps	92.3 Mbps	26.5 Mbps
15ms	100KB	0.1%	30 Mbps	28.4 Mbps	26.5 Mbps
250ms	10MB	0.1%	30 Mbps	23.0 Mbps	2.53 Mbps
250ms	10MB	7%	1 Gbps	22.6 Mbps	285 Kbps
15ms	10MB	7%	30 Mbps	28.7 Mbps	2.31 Mbps
15ms	10MB	7%	1 Gbps	85.2 Mbps	2.58 Mbps

- Delay=250ms, loss=7%, bandwidth=1Gbps with low buffer size was the case where BBR performed better than Cubic.
- Delay=15ms, loss=0.1%, bandwidth=30Mbps with high buffer size was the case where Cubic performed better than BBR.

Example of Experiment

```
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.0.145, port 41130
[  5] local 192.168.0.146 port 5201 connected to 192.168.0.145 port 41140
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-1.00   sec  3.48 MBytes  29.2 Mbits/sec
[  5]   1.00-2.00   sec  3.72 MBytes  31.2 Mbits/sec
[  5]   2.00-3.00   sec  3.41 MBytes  28.6 Mbits/sec
[  5]   3.00-4.00   sec  3.44 MBytes  28.8 Mbits/sec
[  5]   4.00-5.00   sec  3.42 MBytes  28.7 Mbits/sec
[  5]   5.00-6.00   sec  3.43 MBytes  28.7 Mbits/sec
[  5]   6.00-7.00   sec  3.42 MBytes  28.7 Mbits/sec
[  5]   7.00-8.00   sec  3.42 MBytes  28.7 Mbits/sec
[  5]   8.00-9.00   sec  3.43 MBytes  28.8 Mbits/sec
[  5]   9.00-10.00  sec  3.42 MBytes  28.7 Mbits/sec
[  5]  10.00-10.04  sec   137 KBytes  26.0 Mbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-10.04  sec  34.7 MBytes  29.0 Mbits/sec                  receiver
-----------------------------------------------------------
```

- Checking the performance of the algorithm using iperf3 in Ubuntu(linux) server

Conclusion

- BBR works well in high loss, high bandwidth, high RTT(Round-Trip Time) and low buffer size.
- BBR is effective in high-loss scenarios because it avoids the network congestion while other tcp congestion control algorithm decrease their sending rate after detecting network congestion.
- BBR works well in high bandwidth and high RTT since BBR maintains 2 x BDP number of packets in flight(BDP = bandwidth * RTT).
- If there is a loss, BBR overperforms Cubic.
- It is challenging to determine whether BBR or Cubic is superior. It is preferable to select a more efficient congestion control algorithm based on the network environment.

References

1- Neal Cradwell. et al. BBR: Congestion-Based Congestion Control, 2016.
2- A. Balasubramanian, et al. When to Use and When Not to Use BBR: An Empirical Analysis and Evaluation Study, 2019
3- Grant Gross Six Applied Networking Research Prizes Awarded for 2023, 2023.