Week 1 Report and Presentation

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Introduction to TCP-BBR

TCP-BBR (Bottleneck BW and RTT) is new Congestion Control Algorithm developed at Google Inc, which achieves **higher bandwidth** and **lower latencies** for the internet traffics.

TCP Congestion Control Algorithms so far...

1. TCP Tahoe
2. TCP Reno
3. TCP Vegas
4. TCP FAST
5. CTCP
6. TCP BIC
7. CUBIC

So what's new with TCP BBR?

What's New with TCP BBR

All the congestion control algorithms so far are **loss based-congestion control,** i.e they assume packet loss as an indicator of congestion. Packet losses may or may not suggest congestion at the sender side. Others *possible* causes of packet loss are [1][2]:
1. Link Failure.
2. Software bugs on a network device.

Every routers has buffers to queue data packets if the link is full but both small and large buffers cause problems.

1. If the buffer is too large, it leads to a condition of **Bufferbloat** which is the state of undesired latency caused due to lot of buffering.
2. If the buffer is too small they will be full very soon and cause packet loss packet losses will be considered as congestion causing the throughput to decrease subsequently.

Thus the ideal situation is to run the network at the point where the link is just full i.e to operate the link at just the onset of queue formation. TCP BBR focuses on two aspects to operate at the optimal location, which bound the performance:

1. Bottleneck Bandwidth (BtlBw)
2. Round-trip propagation time (Rtprop)

A network is said to be delivering high throughput and low latency when it fulfills two conditions:

1. Rate balance
    a. When the packet arrival rate is equal to the bottleneck bandwidth.
2. Full pipe
    a. The total data in flight should be equal to the BDP (Bandwidth-delay product) where BDP = RTprop * BtlBw.

Both the conditions need to be fulfilled simultaneously since they are not sufficient individually.

Since both the quantities are independent of each other, it becomes necessary to measure both. Both BtlBw and RTprop can change during the span of connection, thus BBR keeps continuous track of both the quantities by measuring RTT and delivery rate.

The BBR Algorithm

There are two main parts of the algorithm:

1. When ACK is received.
    a. Every ACK serves us with a new **RTT sample** and **delivery rate** data.
    b. When ACK is received, the BtlBw is updated.
    c. The application limited check is also done in this segment of the code.
    d. Windowed max BW and min RTT is probed on each ACK.
2. When a packet is transmitted.
    a. BBR paces the data packets to meet the bottleneck rate.
    b. If the inflight data is a greater for (cwnd_gain * BDP, it waits for the acknowledgement)

One of the important switching was the switching of the Google's B4 network's traffic from CUBIC to BBR due to higher throughput of BBR.

Google’s B4 Network

Google has **two internet backbones:**

1. **Backbone B2**: B2 is the old **internet facing network of Google** which faces all of the public user internet.
2. **Backbone B4**: B4 is Google’s SDN based **Inter Datacenter** network not facing the actual traffic.

But why do they need a new backbone?

Reasons for a separate backbone

Google noticed that the inter datacenter traffic is increasing more than the actual user traffic and also that the number of datacenter is modest, which allowed Google to have a separate inter-datacenter backbone. Other considerations that lead to the decision of having a separate backbone are as follows:

1. Elastic Bandwidth
2. Small number of sites
3. Complete control of end application
4. Cost Sensitivity

Centralized Traffic Engineering

1. B4 uses Centralized traffic engineering instead of Distributed Traffic engineering where in a fail is directly reported to the TE for optimal convergence after a failure instead of data finding next optimal path.
2. This results in better utilization of the resources.
3. Helps for modelling test scenarios since the behaviour is deterministic.

SDN (Software-defined Network)

What is SDN?

SDN is software defined network which decouples data and control planes, placing the control planes in the software, making the network administration much more simpler.

Why use SDN for internet backbone?

SDN gives the liberty to move the complex data table lookup from the hardware to the software making it easier for scalability and also for non-TCP specific use.

SDN Architecture for B4

1. Switches
    a. Google uses commodity switches with no software complexity.
2. Openflow Controllers
    a. OFC - ONIX based
    b. Directs switches in forwarding.
    c. Maintains network state (Switching events, application priorities)
3. Central Application
    a. Control centre for the entire setup

B4 separates protocol from the silicon switches while covering the switches with the OpenFlow Agent. And the flow between the two is controlled by a master SDN controller. For fault tolerance, there is a small standy SDN controller. The arrangement is put to two different **sites.**

Challenges with TCP-BBR

Challenges TCP BBR faces even so

1. ACK compression, ACK aggregation/decimation, stretch ACKs
2. Jitter/noise

What is **ACK Compression**?

ACK is the condition when the ACKs are queued at a router or other network devices and then arrive in a burst with much higher rate than the Bottleneck bandwidth.
Current approach:
To filter out high ACK rates based on the fact that the ACK rate can never be greater than the send rate.

More possible research options

1. BBR rate and cwnd selection are based on heuristics.[5]
2. Multiple flow isn't as good as the single flow performance in BBR.
3. Sharing with other TCP can cause a problem
4. Other areas can be found here.

References

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Thank you !!