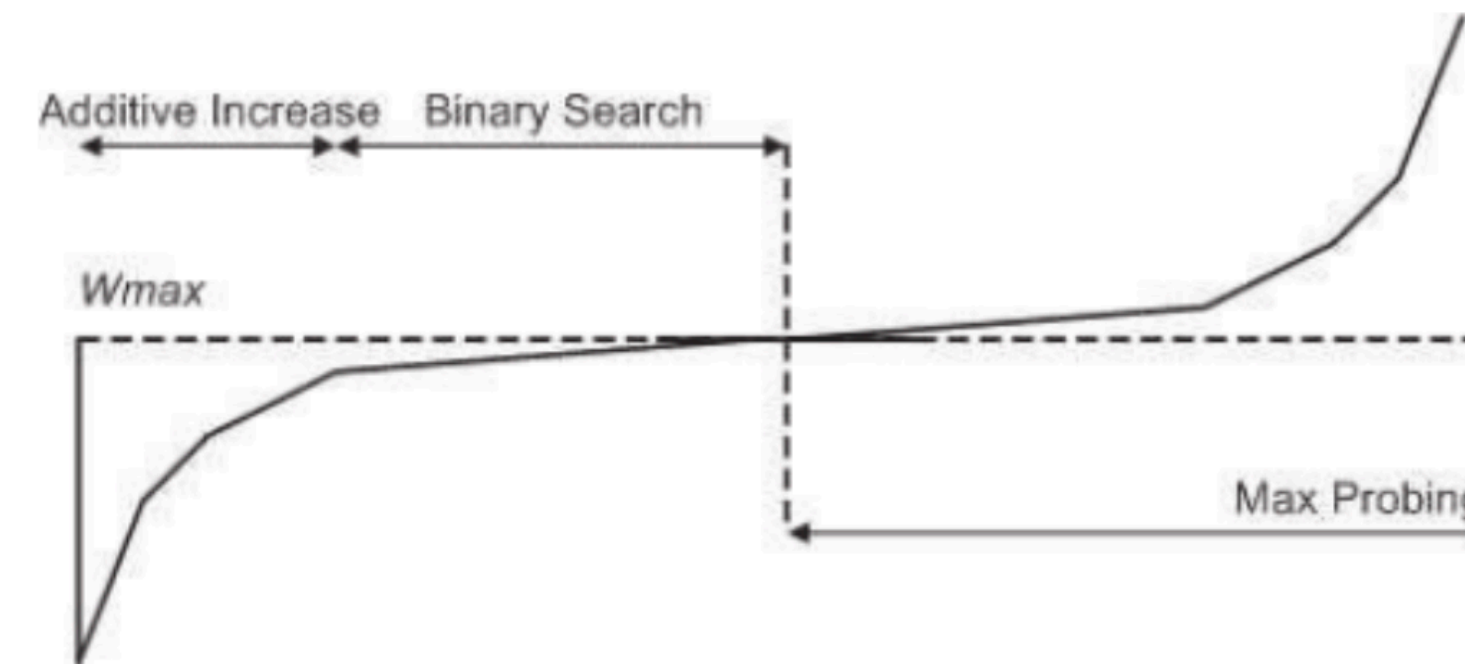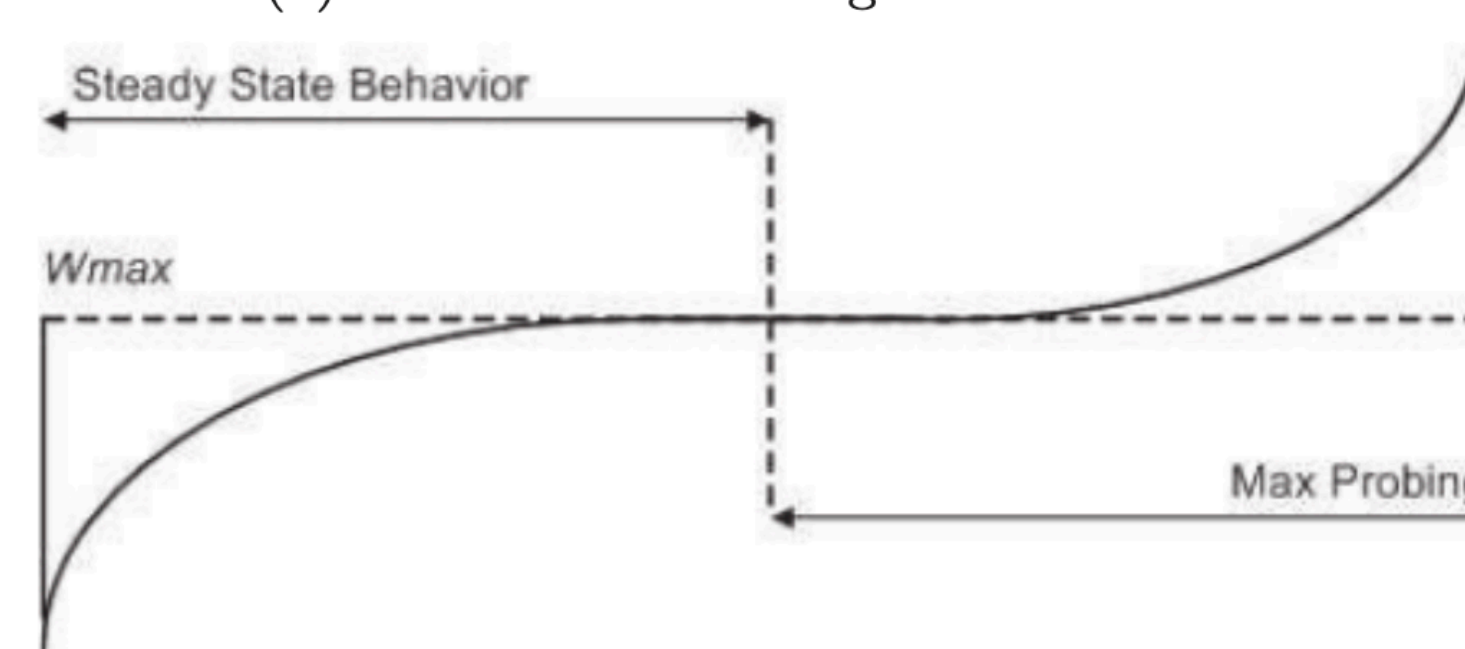# CS 925
Lecture 12
TCP Congestion Control

Thursday, February 29, 2024

TCP CUBIC

▸ An update of TCP BIC (Binary Increase Congestion control)

▸ "modifies the linear window growth function of existing TCP standards to be a cubic function in order to improve the scalability of TCP over fast and long distance networks"

(a) BIC-TCP window growth function.
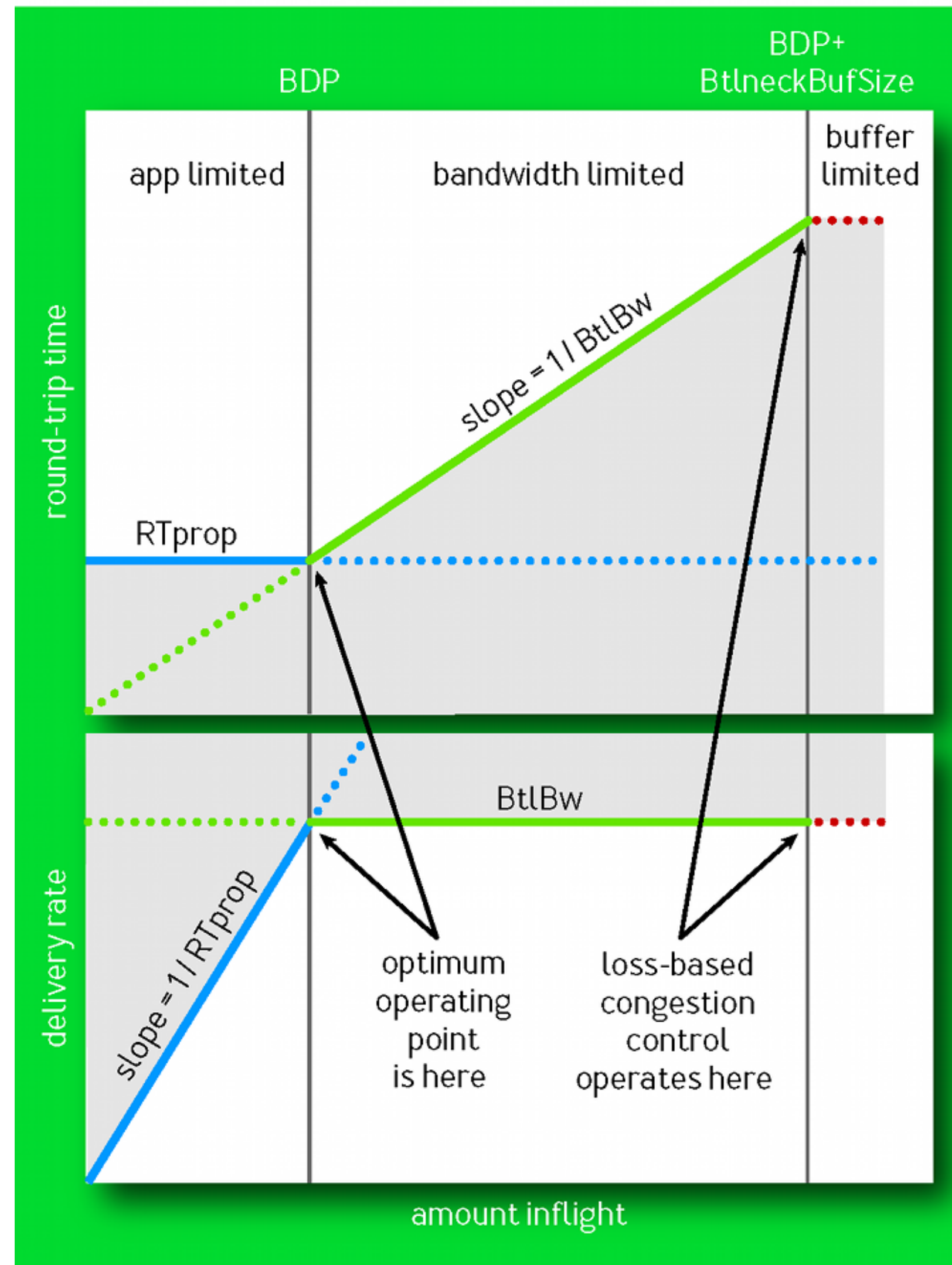

(b) CUBIC window growth function.

TCP BBR

▸ **B**ottleneck **B**andwidth and **R**ound-trip propagation time

▸ Designed by Google (~2016)

- with YouTube as the motivating use case

- available in Linux kernel 4.9+

▸ As the protocol name suggests:

- "BBR congestion control computes the sending rate based on the delivery rate (throughput) estimated from ACKs" (comment in tcp-bbr.c in Linux kernel)
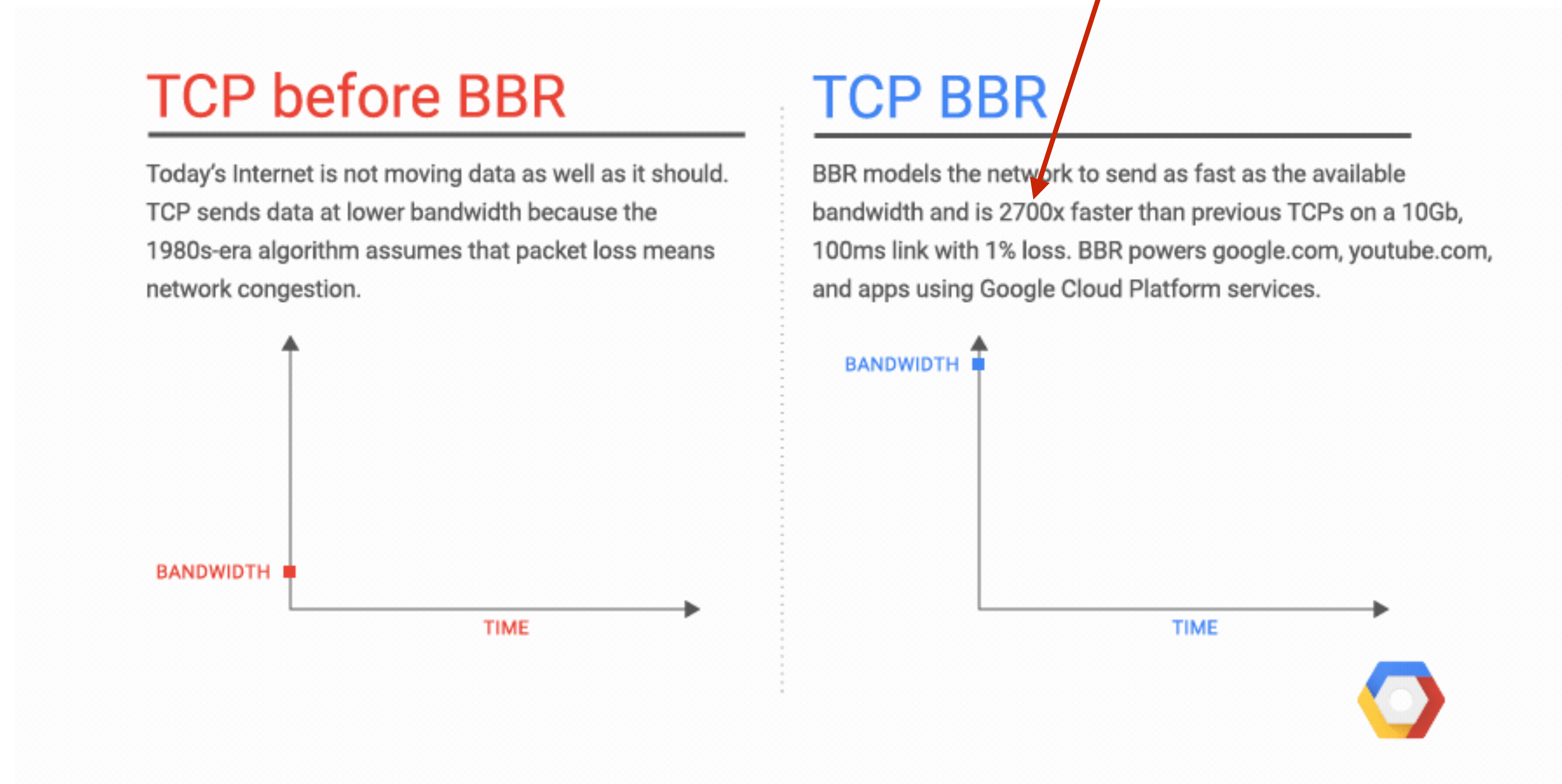
TCP BBR

FIGURE 1: **DELIVERY RATE AND ROUND-TRIP TIME VS. INFLIGHT**

TCP BBR

▸ Congestion control state diagram:

```
* Here is a state transition diagram for BBR:
*
*
*                    |
*                    V
*      +---> STARTUP  ----+
*      |       |          |
*      |       V          |
*      |     DRAIN   ----+
*      |       |          |
*      |       V          |
*      +---> PROBE_BW ----+
*      |      ^    |      |
*      |      |    |      |
*      |      +----+      |
*      |                  |
*      +---- PROBE_RTT <--+
```

TCP BBR

▸ One has to be careful when making claims:

Real-Time Traffic

▸ Elastic vs inelastic traffic

▸ Real-time transport

   – timing is critical (low latency and jitter)

   – perishable data

   – (often) constant rate of delivery

   – (rate adaptation)

▸ Hard vs soft real time…

Media Delivery

▸ Challenges

- multitude of formats

- multitude of server and player (client) capabilities

- multiple simultaneous streams (video, audio, text) delivered

- synchronization between streams

- stream control (play, pause, fast-forward, …)

- changing network conditions

- security and content protection

- real-time, near real-time, on-demand (VOD)