TCP with Many Users

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TCP Goals

[really general congestion goals, any transport]

High utilization of bottleneck link.

Low queueing delay: low loss.

Fair shares of bottleneck.

TCP Techniques

[one ms to transmit, 99 for speed of light]

High utilization with windows. *[keep the pipe full]*

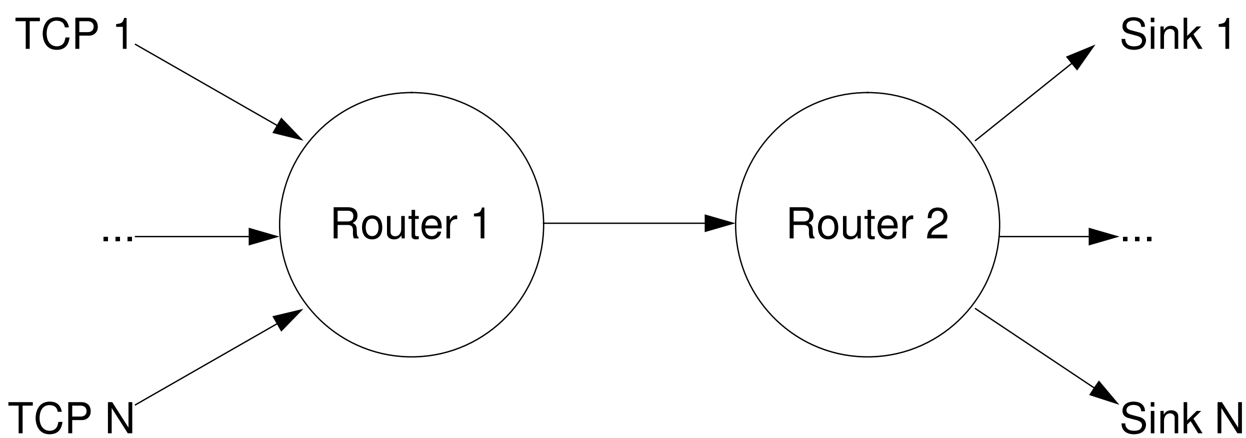
Low queue length with congestion window.

- Increase by 1 each RTT, decrease by half on loss.
- Oscillates around a reasonable value.
- Window controls rate : one window per RTT.

RED distributes losses fairly.

Congestion window + RED = fair shares of bottleneck.

Simulation Configuration



Floyd and McCanne's NS simulator.

Bottleneck: 10Mb/second, 50ms propagation.

Access links: (10Mb/N)*10, 0ms propagation.

Routers: 130 buffers, RED thresholds at 32 and 65.

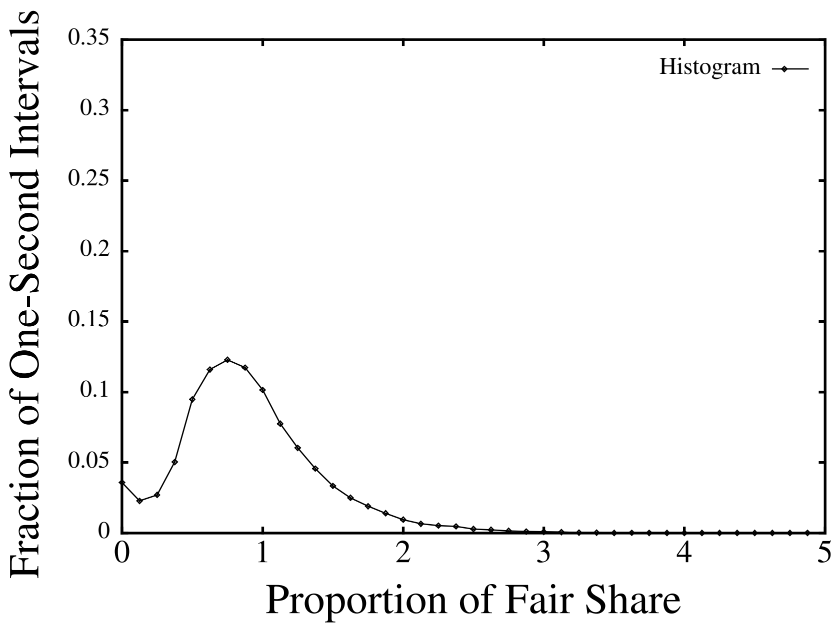
Tahoe, 576-byte packets, 64kB maximum windows.

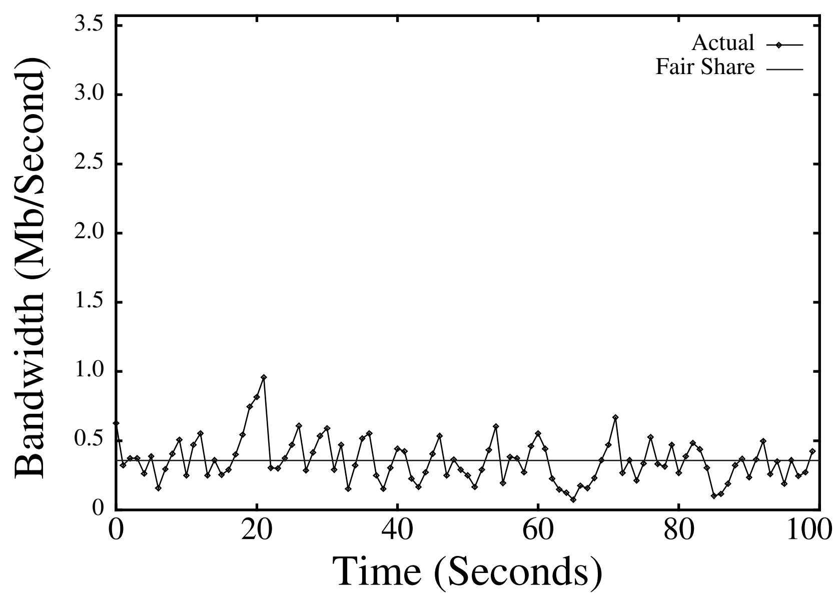
Competing erratic telnet traffic. *[200 seconds]*

TCP Works Well

30 TCPs sharing 10Mb, 50ms WAN link.

Goodput 97%, queue avg 37, 1% loss. *[omit analysis]*





Conclusion: One RTT of buffers is enough. *[full util at 1/2]*

Conclusion: loss rate is low even with high offered load.

How many users?

2300 different TCP sessions in each second at FIX-West.

Not counting all sessions in timeout.

More than one link into FIX-West.

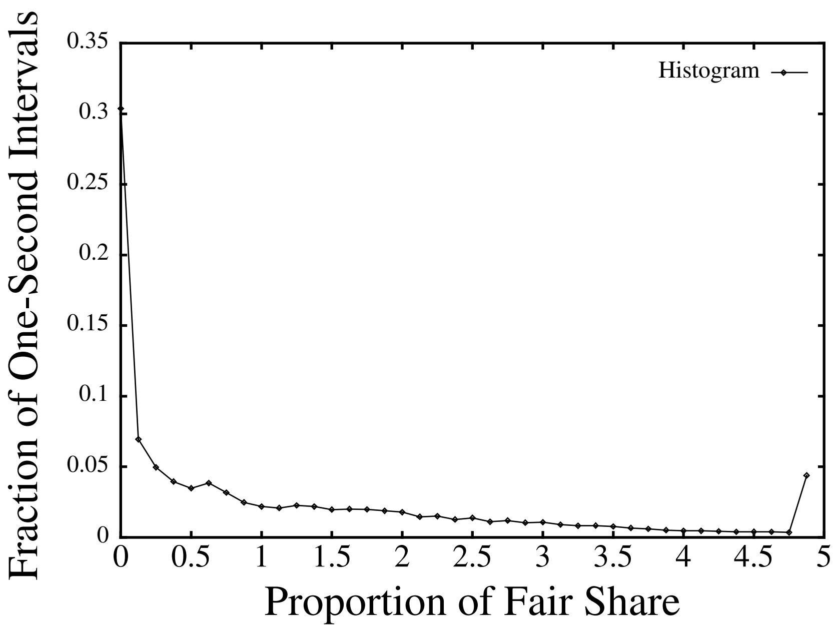
[200 in each second from one part of Harvard.]

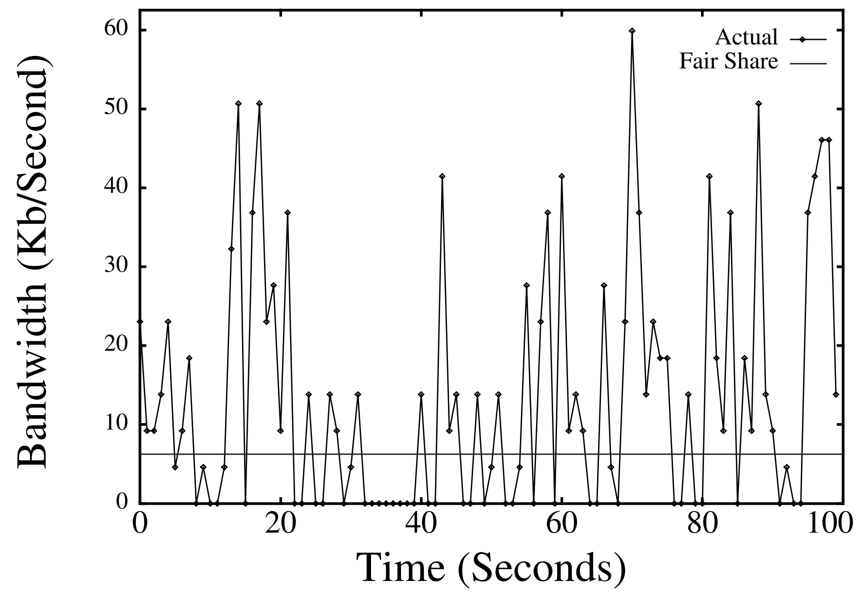
Behaviour with 1600 Flows

No fair shares: too fast or timing out.

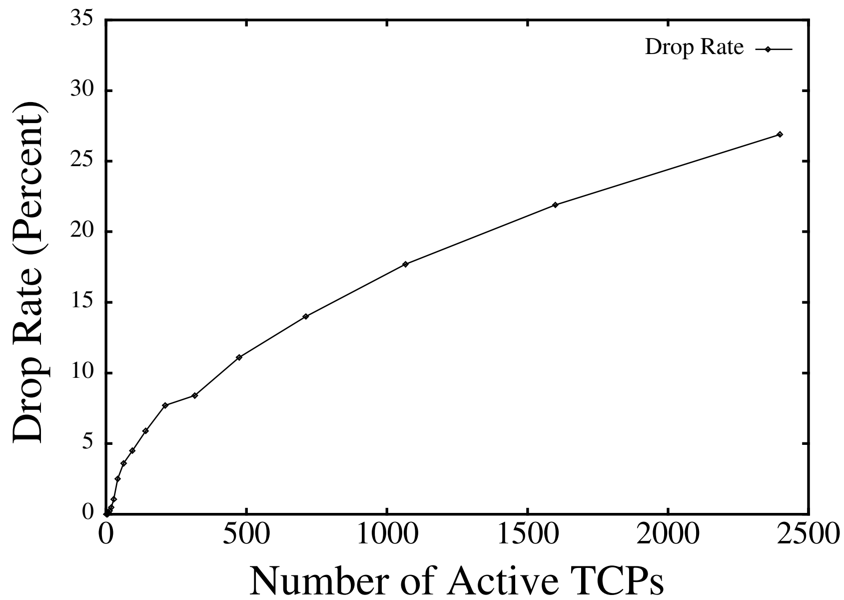
High variation at time scales users notice.

Loss rate is 22%.





Number of Users vs Drop Rate



[derived from ns]

[1000 users gets 15%; right for Internet?]

[Why unfair? Why high loss rate?]

Problem One: Aggressive Ramp-Up

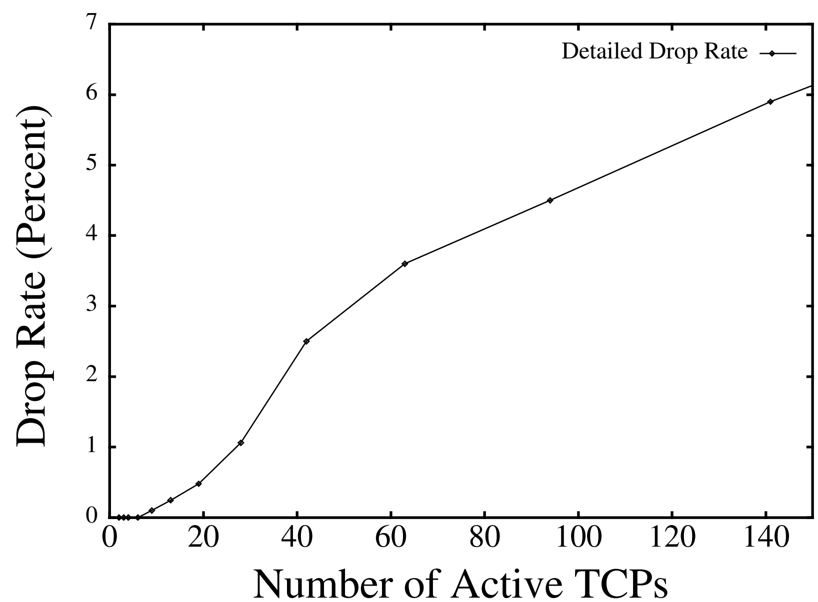
N active TCPs sharing a bottleneck.

Sum of windows increases by N per RTT.

Thus frequency of loss episodes ~ N.

Each episode drops N packets.

Thus loss rate ~ N^2. *[For modest N < 40...]*



Problem Two: Windows Don't Work

Minimum window is one packet.

Minimum rate is one packet per RTT.

For 10Mb, this is more than fair share if N > 217.

Two modes: send too fast, time out for a second.

Loss rate ~ N. *[each sends a packet per second]*

Is the Internet doing this?

Solutions

Shorten timeouts with faster TCP timer? *[but no memory]*

Use Reno or FACK TCP? *[but still have min win]*

Use smaller packets? *[but overhead. or ATM cells?]*

Scale router buffers with number of users.

Scale link bandwidth with number of users.

Use TCP rate control if congestion window <= 1 packet.

Conclusions

Pay attention to performance with many users!

Window congestion control breaks.

Use rate if window is small?

TCP additive window increase is too aggressive.

Goal: 1% loss rather than $O(N^2)$?

MIN(double every 100 packets, 1 per RTT)?

Slides: http://www.eecs.harvard.edu/~rtm/spartan.ps