Comparing edge and host traffic pacing in small buffer networks

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When Internet traffic grows extreamly, core router struggles to keep pace with required switching capasity. If capacity increases, system require more power. To sustain capacity growth, router manufacturers pruduct special systems. In order to perform energy efficient high-speed packed forwarding, such architectures necessarry sacrifice many non-critical functionalities.

When router buffers in the network core are very small (sub-50KB), contention and congestion at the output link can lead to high packet loss and degrading end-to-end traffic performance.

Traffic can be paced in various parts of the network:

Host pacing(TCP pacing)→by the end-host as part of their TCP stack

Link pacing→ by the access link connecting the user to network

Edge pacing→ by yhe edge node that connects into the core network

In this paper, edge pacing and host pacing are compared according to some parameters. These parameter are bottleneck link and non-bottleneck link, low-speed and high-speed links, short and long lived flows, different number of flows and different variant of TCP in small buffers. In addition, the paper explains developing an analitical model and benefits of edge pacing in practical networks.

Efficiacy of edge pacing for TCP traffic

Researches concucted extensive simulations in Ns-2 constracture for evaluating the effectiveness of traffic pacing.

Small buffer link as the bottleneck

When buffers are very small(2,3 KB), packet loss rates at the core link were found to be in excess of 15%(for three senarios-edge pacing,host pacing and unpaced). Edge pacing outperforms host pacing by over 13%. As buffers get larger (>20), the utilization of the core link is near 100%, so there is no room for pacing to improve TCP performance Thus, edge pacing is particularly beneficial in the region of 5-15 KB buffers.

Number of TCP flows

Researchers simulate 100,500 and 1000 flows. When the number of flows is small(100) and buffer sizes are in a certain region (10-30 KB) they find that host pacing gives better performance because burstiness at the botleneck buffers can arice in two ways: (1)an indivudial flow can generate bursty traffic and increased loss,(2) multiple source packets might arrive simultaneously to cause loss. When number of flows is small, host pacing is more effective at reducing source burstiness, when number of flows is large, edge pacing is more effective because, host pacing spaces traffic over a longer window and edge pacing can space from multiple flows.

High speed access links

High speed access links are arising from data centers, enterprise and university networks.etc. Edge pacing obtains higher TCP throughput than host pacing in the small buffers (5-15 KB). Edge pacing is more efficiant for use.

Short-lived TCP flows

Large number of TCP flows (HTTP request) are short-lived. Have slow start phase and often generate more bursty traffic than long-lived flows (congestion). Edge pacing is very effective in combating short time-scale burstiness.

Different versions of TCP

The research was cunducted on Reno, New Reno, SACK, FACK TCP versions. According to results, edge pacing offers better performance than host pacing(by more than 10% in the region 5-15 KB).

Small buffer link not the bottleneck

Researcers used long-lived TCP flows for this parameter. The results that core link does not require more than 10KB of buffering to quarantee zero packet loss. Host and edge pacing approximately the same performance as unpaced, becauseTCP throughput is not sensitive to pacing when the small buffer is not the bottleneck.

Random early detection drop policy

The RED is a queue drop policy. Edge pacing is also effective when the RED drop policy is employed at the core bottleneck link.

Analysing the impact of edge pacer delay

The case of low load,RTT(random trip time) and d is edge delay parameter (0-100), throughput measure increases monotically, but the case of high load, this measure falls monotically.

Mixed TCP and UDP traffic

Edge pacing on the joint performance of TCP and UDP traffic when they multiplex at a core link.(ınternet suggest TCP around 90%, UDP around 10%) Host pacing is applied only to TCP flows. For research, UDP access and edge links are 100 Mbps and Packets sizes are[100, 300] bytes. At the using Poisson UDP; edge pacing is also beneficial for UDP traffic, at the using fBm (fractional Brownian motion) UDP; edge pacing benefits; has long range, dependent properties.

When simulation is small buffer, TCP benefit from larger pacing delay, but when simulation is large buffer, larger pacing delay effects to TCP negatively.

Practical deployment of pacing

The case of edge and host paced,as the fraction of edges/hosts that perform pacing increases,throughput rises gradually. Though fractional deployment of pacing leads to overall throughput improvement for both host and edge pacing, the way these benefits are shared is radically different in the two cases.

Fractional deployment of pacing lead to overall throughput improvement for both host edge pacing. Users use different devicies; PCs, laptops, tablets, smart phones etc. and use different operating systems; Windows, Linux, IOS, Android etc. The kernel update required to incorporate pacing at the host. For edge pacing there is not like this issue since it is entirely under operator control.