Demonstration of Dynamic Class-Based Router Queue Management

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Introduction

The explosive increase in the volume and variety of Internet traffic has placed a growing emphasis on congestion control and fairness in Internet routers. Two approaches for dealing with Internet congestion at the router are *resource reservation* and *active queue management*.

Resource reservation uses packet or link scheduling on multiple logical or physical queues to explicitly reserve and allocate output bandwidth to each class of traffic, where a class can be a single flow or a group of similar flows [8]. However, explicit resource reservation changes the current, effective "best effort" nature of the Internet, and the algorithmic complexity and state requirements of scheduling make its deployment difficult [11].

Active queue management uses packet queuing disciplines on an outbound router queue to actively handle (or avoid) congestion with the help of cooperative traffic sources, such as TCP. One of the earliest and best-known active queue management mechanism is Random Early Detection (RED) [7]. RED which prevents congestion through monitoring outbound buffers to detect impending congestion, and randomly chooses and notifies senders of network congestion so that they can reduce their transmission rate. While fairly handling congestion for TCP flows, RED has been shown to be extremely unfair in the presence of unresponsive UDP flows [9].

Complicating the above traditional congestion control approaches is the presence of multimedia traffic that has strict delay and jitter constraints [1], forcing multimedia flows to use network protocols other than TCP, some of which may be unresponsive to congestion [11, 9]. In addition, traditional router queue management techniques may cause jitter [3] which can severely degrade the quality of a multimedia flow [6].

In order to better manage congestion in the face of varied traffic and in order to better support multimedia flows, we propose *Dynamic-CBT (D-CBT)*. D-CBT extends the work of [11] and recognizes responsive multimedia flows while protecting them and TCP flows by adding a simple class-based static bandwidth reservation mechanism to RED. D-CBT fairly allocates bandwidth by dynamically assigning thresholds to each traffic class such that the sum of the fair share of flows in each class is assigned to the class at any given time. In addition, as a means to improve multimedia jitter, we propose a lightweight packet scheduling mechanism called *Cut-In Packet Scheduling (ChIPS)* which monitors average enqueue rates of tagged and the other flows, and, on transient congestion awards well-behaved (flow-controlled) multimedia flows by allowing their packets to 'cut' in the queue to the average queue length.

To evaluate our proposed mechanisms, we implemented D-CBT and ChIPS in a simulator called NS [10] and compared the performance to that of CBT and RED. Our studies showed that D-CBT improves fairness among different classes of flows and ChIPS improves multimedia jitter without degrading fairness. Details can be found in [4, 2].

Demonstration

Figure 1 depicts a screen shot after an NS run using a modified version of the Network Animator (`nam`). The interface is showing 3 flows traveling through a bottleneck router (node 6). Each flow is a different color, representing a TCP flow, an unresponsive UDP flow and a tagged, responsive UDP flow (a multimedia flow). The interface displays statistics on the number of drops for each class of traffic and the throughput at the bottom of the window. The effects of ChIPS can observed by monitoring scheduling of the different colored packets in the outbound queue. The speed of progression of the simulation is varied using the slider in the upper left-hand corner.

Further details on the technology and performance analysis can be found at: http://perform.wpi.edu/. All source code used in the demonstration is available at the same URL.

References

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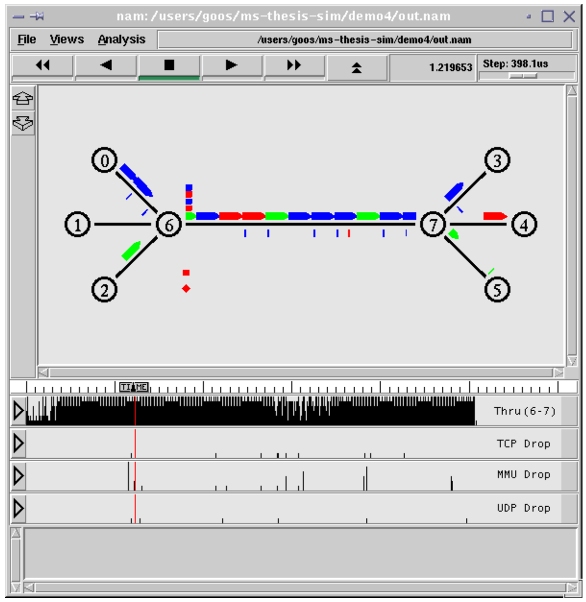

Figure 1: **Depiction of D-CBT in NS using NAM.** There are three flows going through the bottleneck router (6). The red packets are being dropped due to congestion. The bars at the bottom of the window indicate the drops in each class of flow and the throughput on link 6-7.

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