Real Time and Embedded Systems: Programming Assignment

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The Internet has historically been a best effort packet switched network, with no quality of service (QoS) features. With the rise of voice over IP and streaming video applications though, there is a desire in some quarters to deploy QoS mechanisms to give priority to real-time traffic over other data. The aim of this programming assignment is to build a simple network simulator, to demonstrate the benefits such enhanced quality of service can provide.

You should build a simulation of a weighted fair queueing (WFQ) switch in the programming language of your choice. This switch has n input links feeding a single output link of 10Mbps bandwidth, and is traversed by n connections (one from each input link). Each connection, i, is allocated a fraction u_i of the output link bandwidth based on its input rate, such that the total utilisation of the output link $U = \sum_{i=0}^{n} u_i \leq 1$ (i.e., the link is operating at less than 100% capacity). Packets are scheduled onto the output link according to the non-preemptive WFQ algorithm. The switch is output buffered, and packet queues for each backlogged connection may grow without bound. The connections traversing the switch are a mixture of voice-over-IP (VoIP) and Internet Television (IPTV) flows. VoIP flows comprise 160 byte packets that are sent every 20ms for a data rate of 64kbps; IPTV flows comprise 1316 byte packets sent every 10ms for a data rate of approximately 1Mbps. All times and bit-rates are *simulated*. Your system does not have to run in real-time.

Run a range of simulations to measure the performance – in terms of delay through the switch – of a single VoIP flow subject to varying degrees of cross traffic (other VoIP flows, other IPTV flows, and a mix of the two, with varying start times and durations, and with or without random perturbation of the arrival times of the cross traffic), ensuring that you do not overload the output link. Plot both time series graphs of the queueing delay experienced for the measured VoIP flow, and also histograms showing the distribution of the queueing delay. Discuss and explain the parameters you chose for your simulation, and the results shown in your graphs.

Repeat your measurements using a simulation of a router that has a single unbounded FIFO queue for the output link in place of the WFQ router. Discuss your results, and compare and contrast the performance of WFQ and FIFO queueing.

This assignment is worth 15% of the mark for this course (5% for the implementation; 5% for the experiments; and 5% for the discussion of the results). You should submit a single written report outlining the design and implementation of your code, describing the experiments you undertook and justifying your choice of simulation parameters, then presenting and discussing your results. This report should include printouts of your code in an appendix. Completed assignments must be submitted by 1:00pm on Friday, 12 March 2010 via the locked box outside the Teaching Office. You must include a pink declaration of authorship form with your submission. Late submissions will be awarded zero marks unless accompanied by a valid special circumstances form.