Robust Resource Sharing in Networks: Insensitivity and Tractability

Ravi R. Mazumdar
University of Waterloo, Canada

File transfers compose much of the traffic of the current Internet. The main measures of the quality of service for this type of traffic are the transfer rates and duration of the file transfer. File transfers are modeled as a fluid elastic flow, whose transmission rates are adaptable depending on the network congestion or the number of other flows that share the link. There are many models for sharing the available bandwidth on a link and the most common model is that of processor sharing. Such a model assumes that the flows sharing the link are homogeneous. However, in practice, flows have different bandwidth requirements. A major issue is how to share the bandwidth at links in a network when it is accessed by heterogeneous flows that results in a well behaved stochastic network.

One approach is via the so-called notion of balanced fairness that has been studied by Bonald, Proutiere, and Massoulie. Recently it has been shown that balanced fairness and so-called proportional fairness associated with fair rate control schemes coincide when there are many users. Balanced fair allocations have important implications for the probabilistic behavior of the network in that the stationary distributions are insensitive to the flow size distributions. This thus has close connections with multi-rate Erlang loss models and yet they are different since flows are not blocked.

In the talk I will present the background on insensitive network allocations and their relation to the proportional fair allocations. The talk will focus on congestion in links that operate under a balanced fair allocation scheme for heterogeneous flows with differing maximum or peak bandwidth requirements. In particular we address how various congestion measures can be explicitly computed in large systems where the links are accessed by a large number of independent flows using ideas from local limit large deviations of convolution measures associated with multirate Erlang systems.

Extensions to networks and mechanism design for insensitive bandwidth allocation will be discussed.