Name: Sreenivas Gollapudi
Dissertation Title: Selfish Flows: Where QoS Meets Game Theory
Committee:
Prof. Aidong Zhang (Chair)
Prof. Bharat Jayaraman
Prof. Shambhu Upadhyaya
Date : August 2, 2004
Venue : Bell 224
Time : 10:00 AM

1 Abstract

QoS management is central to the efficient working of a large network such as the Internet. Owing to the size of such networks, it becomes difficult to enforce any central scheme to monitor flow behavior or perform functions such as routing and bandwidth allocation. Furthermore, such networks also comprise of heterogeneous flows using different protocol stacks at the end points in the network. In such cases, the network users act in accordance to their interests to receive network resources. This selfish behavior by the network users largely tends to undermine the overall performance and stability of the network. Therefore, the stable functioning of the network is largely dependent on the socially responsible behavior of the network users. In the absence of such behavior, the stability of the Internet is at risk of collapsing as it did over a decade ago.

Our contributions in this study are twofold - the first part of the study deals with identifying misbehaving flows in the network. Here we assume most of the flows are well behaved, i.e., behave in a socially responsible manner and detect the misbehaving flows. To keep the cost of identifying the misbehaving flows low, we propose data stream algorithms to detect misbehavior only if ϵ fraction of the bandwidth is lost to such flows. In another scenario, we propose a stream/sort model to traffic anomalies, such as DDoS attacks, that can potentially cause severe degradation of QoS in end systems.

The second main contribution of this study is in designing mechanisms for bandwidth allocation and QoS routing in networks such that selfish behavior of flows leads to socially desirable outcomes both from a flow's point of view of receiving a fair amount of a network resource and the network's point of view of maximizing throughput and at the same time satisfying the QoS requirements of as many flows as possible. We study allocation and routing models in the presence of selfish flows and when the purchasing power varies among users. To this end, we present a mechanism for bandwidth allocation based on differential pricing. We analyze the fairness and truthfulness properties of our mechanism from a game-theoretic perspective. We show that it produces allocations that provably satisfy a variant of the classical notion of max-min fairness. Furthermore, we show that the Nash equilibrium induced by our mechanism leads to allocations that are comparable to "socially optimal" allocations.