ATM Efficiency Under Various Pricing Schemes

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Abstract

ATM is designed to enjoy some of the efficiency benefits of statistical multiplexing, while providing the resources necessary to support an integrated services network. The performance of the network depends on the extent to which resources are effectively shared among the applications running on the network. At the same time, increased sharing risks congestion, which degrades service quality. One of the great challenges for ATM is to design mechanisms that balance the competing objectives of resource sharing and congestion avoidance. We propose improving the efficiency of the network by more closely involving the users in session control. We explain how to do this using feedback mechanisms, then compare the performance of a simulated network using different mechanisms based on pricing.

To understand the role of feedback, we categorize network applications into two types: adaptive and non-adaptive. With adaptive applications users are willing and able to adjust the sending rate during a connection. Network feedback provides information about the state of network usage to guide adaptation. However, to maximize the value of the network to its users, it is necessary to induce adaptive users to respond to feedback in a way that ensures that the connections most highly valued by the users get the best performance. Pricing is a decentralized approach to obtaining a socially efficient allocation of scarce network resources. Therefore, we explore feedback in the form of prices per cell that are dynamically adjusted in response to the state of the network.

We simulate a simple ATM network with no pricing and simple but traditional call admission and scheduling protocols. We then simulate the network with two different types of pricing feedback: closed-loop and open-loop (“smart markets”). With closed-loop pricing, the network measures the state of congestion, calculates a price per cell for traffic offered in the next period, then reports that price back to users. Users decide how many cells to send during the next interval: when congestion is high, the price is high, and users will tend to send fewer cells. With open-loop pricing, users announce their

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willingness-to-pay for a given cell to be admitted to the network during the current pricing interval. The network then rank orders the cells according to the users’ valuations, and admits the most highly valued cells; the rest are dropped (but may be offered again during the next interval).

We use the simulations to explore the feasibility of these feedback mechanisms, and to compare the performance of the network using different mechanisms. Although we measure and compare traditional performance measures (such as the dropped cell rate), we focus on a user-centric performance measure: the sum of perceived user benefits from utilizing the network.