TUBE: Pricing by Timing

Carlee Joe-Wong, Sangtae Ha, Soumya Sen, Mung Chiang
Princeton University

Abstract

Wireless Internet data usage is doubling every year. Users are consuming more of high-bandwidth data applications, with usage concentrated on several peak hours in a day. We review many of the pricing schemes in practice today and analyze why they do not solve this problem of growing data traffic. We propose a time-dependent pricing scheme as a viable solution, charging different prices for Internet access at different times. This pricing induces users to spread out their bandwidth consumption across different times of the day, with a large potential impact on ISP (Internet service provider) revenue, congestion management, and consumer behavior. We develop an efficient way to compute the cost-minimizing time-dependent prices for an ISP, using both a static session-level model and a dynamic session model with stochastic arrivals. Our representation of the optimization problem yields a formulation that remains computationally tractable for large-scale problems. We next show survey results demonstrating that users are willing to defer data usage in exchange for a lower monthly bill, as well as numerical simulations illustrating the use and limitation of time-dependent pricing. Finally, we present our system integration and implementation, called TUBE (Time-dependent Usage-based Broadband price Engineering), and proof-of-concept experimentation.

The TUBE system is currently being tested in a local trial with fifty participants. Thirty participants use iPhones and twenty use iPads. The participants' 3G traffic is routed through our TUBE servers via a secure VPN, allowing us to measure the traffic volume and compute time-dependent prices accordingly. The iPhone participants receive monetary rewards for their participation based on a maximum reward, less the amount spent according to time-dependent pricing. The TUBE project acts as an ISP to the iPad participants; we pay their usual monthly bills for 3G data, and they pay us according to our time-dependent pricing algorithms. The iPad user interface includes an automated "recommendation" feature, which schedules applications for users so that they spend less than a specified monthly budget. The recommendation engine accounts for and dynamically adjusts user preferences for which applications to delay to lower-priced periods.

A version of this paper was presented at ICDCS 2011; the technical report is available at http://www.princeton.edu/~chiangm/timedependentpricing.pdf.

Speaker: Carlee Joe-Wong
Position: Graduate Student
Affiliation: Applied and Computational Mathematics, Princeton University
Submission Type: Talk, poster or both