Network Pricing and the Price of Anarchy

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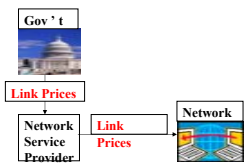
Motivation

We study a network pricing model of network service providers competing to maximize profit while their clients attempt to gather utility. The model involves numerous factors (network capacity, link prices, latency, flows, etc), which thus increases the complexity of our analysis. The design of a computer system capable of accounting for all such factors and helping us determine the optimal benefits present in various network setups was necessary.

Model

- *Social Optimum Configuration* (SOC)



Government (social planner) assigns all network link prices to providers

- *Nash Equilibrium Configuration* (NEC)

Network link prices are selfishly or non-cooperatively chosen by providers themselves

Price of Anarchy

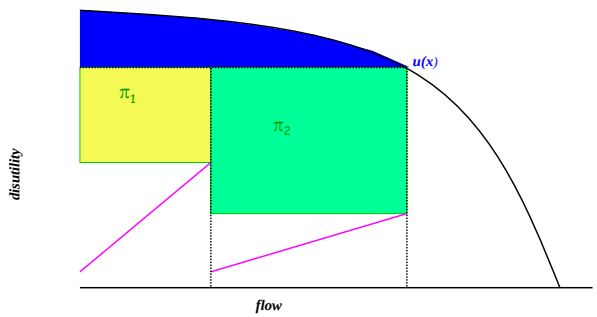
Definition: Ratio of the social welfare (providers' profit plus clients' utility) attained in the SOC versus the social welfare attained in the NEC.

Purpose: The process of finding the price of anarchy helps us determine the economically optimal benefits that could be attained in various network configurations (notably the ones in our model).

Procedure:

- Set up network characteristics (with variables such as: flows, latency, capacity, user utility, etc…) so as to configure networks in a realistic manner
- Use optimization techniques to compute the maximum social welfare attained by the network when it reaches equilibrium (this step varies from one network type to the other)
- Find optimal flows pertinent to that equilibrium state as well as the optimal prices that satisfy such flows

Results: Social welfare, optimal flows plus optimal prices for all links is determined for different network configurations. Then could the price of anarchy also be computed (this price is no more than 1. 5 – meaning the welfare attained in SOC is at most 1. 5 times that attained in NEC).



Measuring social welfare: *U(p) = provider profit [Σiπi] + user utility [0∫F (u(x)-d)dx]*

Future Work

- Render our computer system more flexible so that it handles nonlinear functions efficiently (as opposed to only linear functions)
- Make the model even more realistic by enabling our system to include more variables (i.e. how much each customer values the price amount assigned to a link or the latency present on that link, etc)

References
J. Musacchio and S. Wu, "The Price of Anarchy in a Network Pricing Game," July 2007

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