HY537: Έλεγχος Πόρων και Επίδοση σε Ευρυζωνικά Δίκτυα

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Economics

Contents

The context

- Communication services are economic commodities
- **Supply factors:** amounts of services produced
  - technology of network elements with management and control rules, network cost
- **Demand factors:** amounts of services users want
  - trade-offs between quality of service and willingness to pay
  - derived demand
- Market interaction of network service providers and consumers trough prices
  - competitive equilibrium: ***social optimality***

Terminology

- **Terminology**:
  - **price**: associated with unit of usage
  - **tariff**: price structure
    - general form of price, e.g., $a+px$ (two part, nonlinear, tariff)
    - *instrument for pursuing policy objectives*
    - Nonlinear prices = nonlinear tariff
  - **charge**: amount to be paid (bill)

tariff = charging model

Who sets prices ?

Three possible answers

- Market: supply = demand
- Producer: maximize profit or deter potential competitors
- Principle: induce specific action. Principle can be
  - Provider
  - Regulator

- Different approaches lead to different prices
- Even cost can have multiple definitions
  - Historic cost (cost when device was produced)
  - Opportunity cost (value of producing it)
  - Equivalent asset cost (cost of replacing it)

The customer's problem

- Assume a market with n customers and k services
- Set of customers: N={1,…,n}
- Customer i can buy a vector quantity of services x=(x1,…,xk) for price p(x), where

$$p(x) = \underset{\{x_i\}}{p^{\mathrm{T}}} x = \sum_j p_j x_j \qquad p = (p_1, \ldots, p_k)$$

- Assume that the available resource are unlimited, and customer i seeks to solve the problem

$$x^i(p) = \arg \max_x [u_i(x) - p^{\mathrm{T}} x]$$

- xi(p) is called demand function

User utility

- User utility ui(x): level of satisfaction for quantity of service x
- Usual to assume that ui() is strictly increasing and strictly concave
  - But this is not always the case
- Marginal utility of service j $\dfrac{\partial u_i(x)}{\partial x_j}$
  - Decreasing function of j

Taking into account user utility

- User utility: $u_i(x_i)$
- Global planning problem:

$$\max_{\{x_i\}} \sum_i u_i(x_i) \qquad s.t. \quad \sum_i x_i \le C$$

- But, difficult to know all utilities

Taking into account user utility

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- But, difficult to know all utilities
- Under conditions (utility is concave), the above can be solved distributed using prices and allowing each user *i* to solve $\max_{x_i} \{u_i(x_i) - px_i\}$
- Price p set such that $\sum_i x_i(p) = C$
- Demand function $x_i(p)$

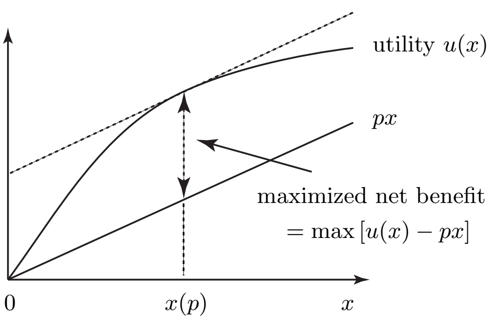
Properties of approach

- Network does not need to know utility of all users
- Decentralized solution, each user acts to maximize their own benefit
- Sharing done by users, not internal network mechanisms
  - Network only provides “price” (=congestion signal)
- Incentive compatibility: best solution for each user maximizes aggregate utility (social welfare)
- Efficient (economic) resource utilization: capacity is used in full, by those who value it most

Net benefit maximization

- Customer’s net benefit or consumer surplus:

$$CS_i = \max_x [u_i(x) - p^{\mathrm{T}} x]$$



Net benefit maximized at $p = \dfrac{\partial u(x)}{\partial x}$

Demand curve and surplus

- Consumer surplus

$$CS(p_j) = \int_0^{x_j(p_j)} p_j(x)dx - p_j x_j(p_j)$$