Pricing – part 1

S-38.041 Networking Business

Basic concepts

Competition

- Who sets the price? Basic cases:
  - *Pure monopolist* sets the price to maximize his supplier surplus (i.e. profit)
  - *Regulator* sets the price to maximize social surplus (regulated monopoly)
  - *Pure competition* sets the price to maximize consumer surplus (all players are *price takers*)
  - *Oligopoly* allows the choice of price and quantity which triggers pricing games, and strategies!
- *Tatonnement*, the iterative process where the market equilibrium is achieved via price changes (assuming static utility and cost functions), suffers from
  - Utility and cost functions evolving too fast in innovative markets
  - Some forms of utility functions defying convergence
  - *Untruthful declarations* (i.e. lying can be beneficial)
  - Finite capacity constraints causing delay

Price, tariff, and charges

- Customers pay *charges* computed from *tariffs*
- *Price* is a charge associated with one unit of usage
- Telecom tariffs are typically non-linear and two-part
- Two-part tariffs are of the form ***a+bx***
  - *a* is fixed charge (e.g. monthly GPRS access charge)
  - *x* is quantity (e.g. number of GPRS megabytes per month)
  - *b* is unit price (e.g. price per GPRS megabyte)
- Two-part tariff reflects the operator's cost structure, i.e. fixed vs. variable costs
- How to set optimal tariffs?
  - High fixed charge discourages small customers
  - High unit price discourages large customers

Pure monopoly

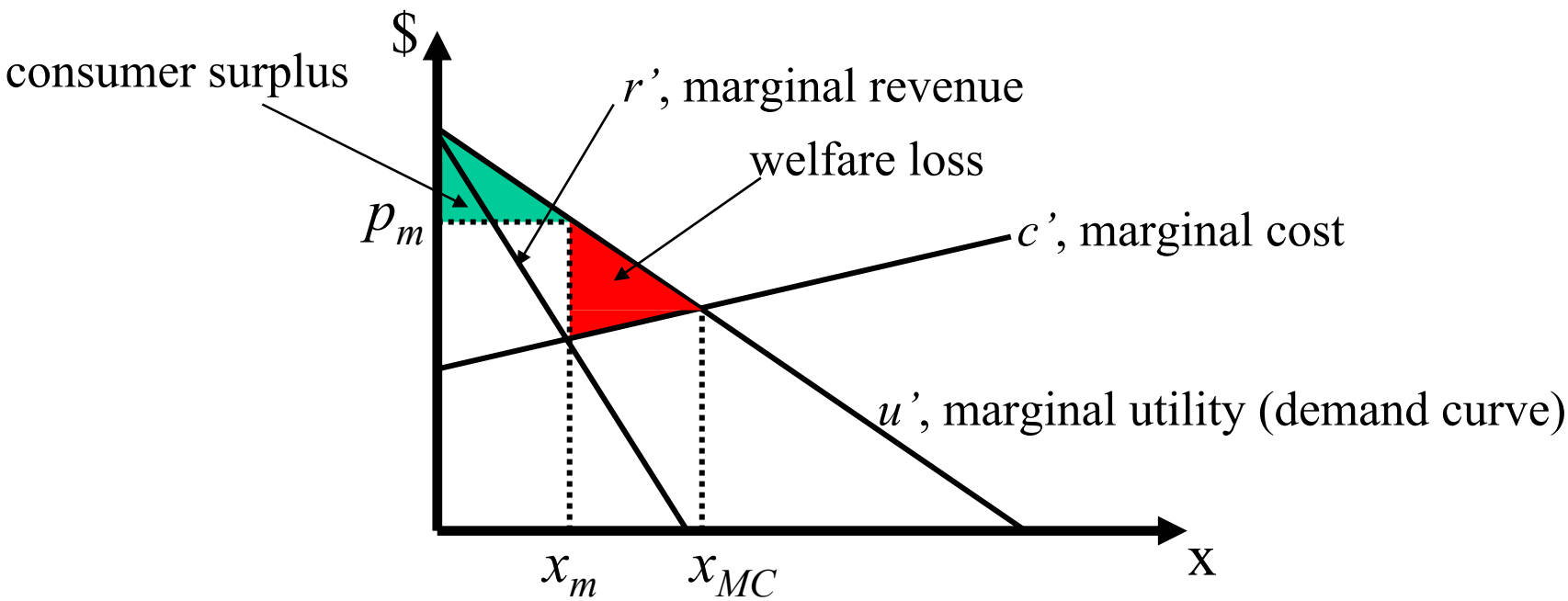
Basics

- Monopoly is a situation where a single supplier controls the quantity of production, and thus also the price
- Monopoly is likely when the market involves
  - positive network externality (the average utility per customer increases with larger customer base)
  - economy of scale (the average cost of production decreases with the quantity of good produced)
  - economy of scope (the average cost of production decreases with the number of different goods produced)
- Mathematically, costs are said to be subadditive if $c(x+y) \leq c(x)+c(y)$, when all suppliers share the same cost function $c(\cdot)$

Pure monopoly

Profit maximization

- Monopolist's problem: maximize$_p$ $[\sum_j p_j x_j(p) - c(x)]$
- Profit is maximized when *marginal revenue* equals *marginal cost*
- Welfare would be maximized if price is set to marginal cost
- Regulator would like to enforce *marginal cost pricing*



Pure monopoly

Price discrimination

- First degree price discrimination (i.e. personalized pricing)
  - Operator maximizes profit per customer, $p_i = u_i$
  - Also called perfect price discrimination
  - All customer surplus turns into operator surplus
- Second degree (i.e. versioning, quantity discrimination)
  - Operator posts a set of volume-based prices
  - Customer self-selects to maximize surplus
  - Optimal volume pricing holds the following properties
    - The highest demand customer chooses the version of lowest price per unit
    - Monopolist takes all surplus of lowest demand customers
    - The higher demand customers receive an informational rent
- Third degree (i.e. market segmentation, group pricing)
  - Grouping based on pre-selection, e.g. student id card
  - Different price elasticities, $\varepsilon_i=(\Delta x/x_i)/(\Delta p/p_i)$, enable different prices

Pure monopoly

Service bundling and differentiation

- Bundling involves a service package not priced as a sum of the prices of individual services
  - Bundling sometimes enables perfect price discrimination
  - Bundling reduces dispersion in willingness to pay and thus enables greater revenue
- Operator can segment the market via service differentiation
  - Versions of service must not substitute each other (e.g. QoS)
  - Operator must prevent harmful reselling (cmp. wholesale vs. retail)
  - Operator may not be able to price discriminate based on content
    - Operator not allowed to read user-created content
    - Technology-based differentiation difficult (e.g. IP vs. SMS)
    - Operator's charging can be by-passed (e.g. credit cards)

Perfect competition

- Regulator cannot be satisfied even on a welfare maximizing monopoly since innovation requires competition
- Under perfect competition
  - operators participate if, $py^* \geq F + c_v(y^*)$, where y^* is the optimal service volume and F is fixed cost
  - *market clearance*, i.e. demand = supply, maximizes social surplus
  - operators experience zero *economic profit* in the long-run (*business profit* can be positive)
- Perfect competition may not be achieved due to
  - non-identical service offerings
  - limited visibility to prices of other players
  - high switching cost paid by customers for changing operators
- An example of high switching cost is the change of a phone number, which the regulator often solves via number portability

Oligopoly

- Oligopoly is typical in telecommunications: a partly competitive and partly regulated market with a small number of operators
- Operator oligopoly can be seen as a game-theoretic set-up between operators, customers, and the regulator
- Game concepts: zero-sum game, Nash equilibrium, public goods, free rider problem, cartel, one-shot vs. repeated games
- Game models for a small number of operators
  - Cournot (quantities posted, prices adjust, all sold)
  - Bertrand (prices posted, quantities adjusted by customers)
  - Stackelberg (for duopoly, either price or quantity leadership)

Cost-based pricing

Motivation

- Marginal cost pricing maximizes consumer surplus but causes problems to operators
  - Exclusion of fixed costs
  - Prices difficult to compute
  - Prices can be close to zero or infinity
- Operator's cost recovery can be supported by weighting the social surplus function in favor of operators (Ramsay pricing)
- Two-part tariffs support the two aspects of cost recovery: fixed vs. variable costs, short vs. long-term
- Burden of fixed costs can also be reduced by cutting capacity via peak-load pricing
  - Traffic load is moved from busy hour to other time periods
  - Traffic loss vs. capacity savings?

Cost-based pricing

”Fair” prices

- Cost-based pricing assumes that costs are shared in a ”fair” way among customers
  - *sustainable prices* reflect actual costs and discourage inefficient ’hit-and-run’ competition
  - *subsidy-free prices* reduce churn of subsidizing customers
- Conditions for subsidy-free pricing are
  - charge made to any subset T of customers N is no more than the stand-alone cost of providing services to those customers

    $$\sum_{j \in T} c_j \leq c(T), \text{ for all } T \subseteq N$$

  - charge made to any subset of customers is at least the incremental cost of providing services to those customers

    $$\sum_{j \in T} c_j \leq c(N) - c(N \backslash T), \text{ for all } T \subseteq N$$

  - assuming a set of n customers $N = \{1,2\ldots,n\}$, subadditive cost function, charges c_j, cost recovery $\sum_{j \in N} c_j = c(N)$

Cost-based pricing

Implemention issues

- Problem of knowing the real costs per service
  - Future is less known than history (plus accounting delays)
  - Cost structures keep changing because of technology evolution
  - Common costs dominate
- Solutions for allocating costs to services
  - Top-down approaches (based on historic costs)
    - Fully Distributed Costs, FDC (flat, coefficients, ad hoc?)
    - Activity-Based Costing (e.g. hierarchical process)
  - Bottom-up approaches (based on current costs)
    - Efficient Component Pricing Rule, ECPR
    - Long-Run Incremental Cost, LRIC(+)
- LRIC+ is complex, but favored by regulators because of subsidy-free prices, legacy-free costs, and the right competitive signals to the market (fairness toward incumbents?)

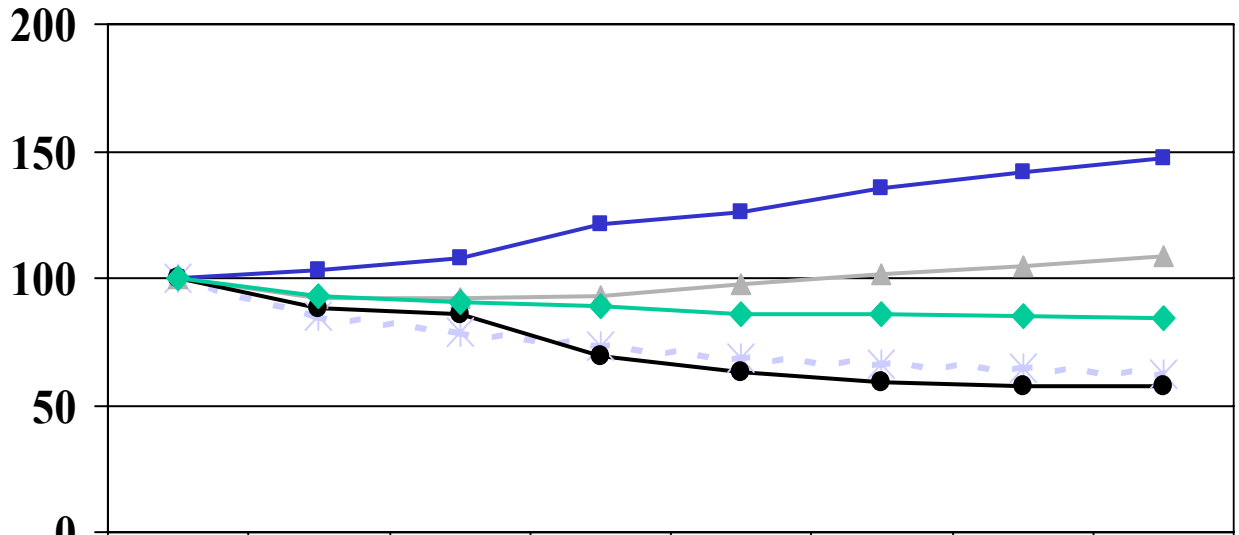
Flat-rate pricing

- Price is set a priori, but the real cost can only be known a posteriori, e.g. broadband Internet access
- Pros
  - Simple and cheap to implement for operators
  - Predictable to customers
- Cons
  - High social cost because of waste of resources (obs. cost savings!)
  - Unfair because of subsidies (only if customers know and care!)
- How to improve flat-rate?
  - Divide flat-rates in intervals, e.g. ADSL with multiple speeds
  - Add usage-based tariff for extra usage, e.g. GPRS block pricing

Access vs. backbone transport

- Tough competition in backbone
  - Capacity-based wholesale pricing dominates
  - Service differentiation difficult
  - Prices close to marginal cost of competition
  - Marginal cost of new traffic getting close to zero because the excess fiber capacity becomes sunk cost
- Monopolies and oligopolistic competition in access
  - Operators capable of bundling and differentiating
  - Evolving technology maintains dynamics in pricing
  - Regulators pushing cost-based pricing and LRIC+

Price impact of competition



	1995	1996	1997	1998	1999	2000	2001	2002
Mobile calls	100	85,3	78,8	73,4	68,4	66,1	64,2	62
Local services	100	103,5	108,2	121,1	126,1	135,5	141,8	147,6
Long-distance calls	100	92,4	92,1	92,8	97,5	101,3	105	108,8
International calls	100	87,8	86,1	69,4	62,8	59	57,7	57,7
Total	100	93	90,7	88,7	85,8	85,6	85,2	84,6

Source: Ministry of Transport and Communications/Price level of the Finnish telecommunications charges 2002, 15/2003

Willingness to pay per bit

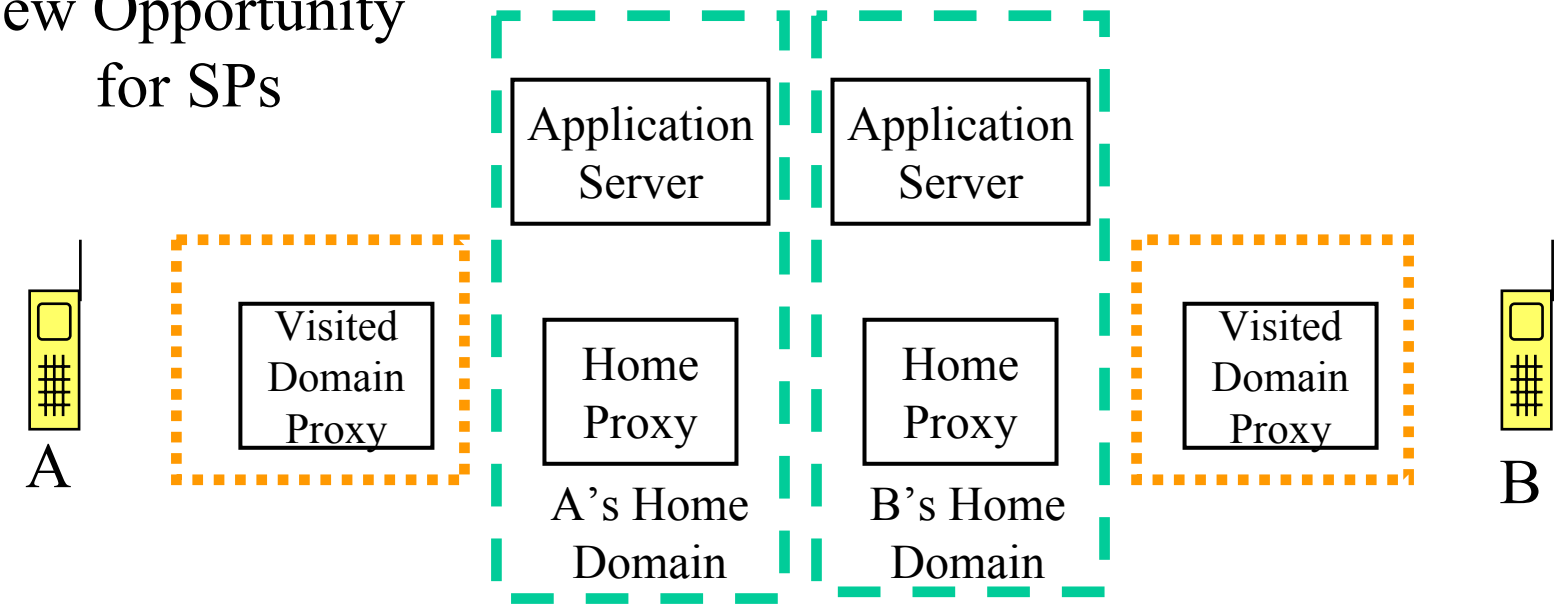
	Volume or bit rate	Acceptable price	Value (€/Mbyte)
SMS	160 bytes	0.16 €/message	1000
Voice	16 kbit/s	0.12 €/min	1
Movie	2 Mbit/s	0.9 €/h	0.001

There are 6 orders of magnitude differences in willingness to pay for existing services! How to maintain the value of service differentiation?

3G unbundling?

Person-to-person via SIP

New Opportunity for SPs



- Services are always provided by the home domain Proxy and Application Server
- Media plane routing and service routing are independent
- SIP service routing allows attaching any Application Server to any call be the AS private or owned by an operator => Future service market is very competitive! => Consumer surplus increasing

Pricing in practice?

Systematic use of pricing theory?

OR

Artistic innovation by trial and error?

Yes, both, continuously!