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 $p \left[ \sum p_j x_j(p) - c(x) \right]$
- 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, \( \varepsilon_i = \frac{\Delta x_i}{x_i} / \frac{\Delta p_i}{p_i} \), 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
    \[ \sum_{j \in T} c_j \leq c(N) - c(N \setminus T), \text{ for all } T \subseteq N \]
  - assuming a set of $n$ customers $N = \{1,2...,n\}$, 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

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<th>Local services</th>
<th>Long-distance calls</th>
<th>International calls</th>
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Source: Ministry of Transport and Communications/Price level of the Finnish telecommunications charges 2002, 15/2003
Willingness to pay per bit

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<th>Volume or bit rate</th>
<th>Acceptable price</th>
<th>Value (€/Mbyte)</th>
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<td>SMS</td>
<td>160 bytes</td>
<td>0.16 €/message</td>
<td>1000</td>
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<tr>
<td>Voice</td>
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<td>0.12 €/min</td>
<td>1</td>
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<tr>
<td>Movie</td>
<td>2 Mbit/s</td>
<td>0.9 €/h</td>
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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!