

Congestion pricing principles

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Note: This document represents my own views and does not necessarily reflect the views of my employer or anyone else, living or dead.

Value maximization

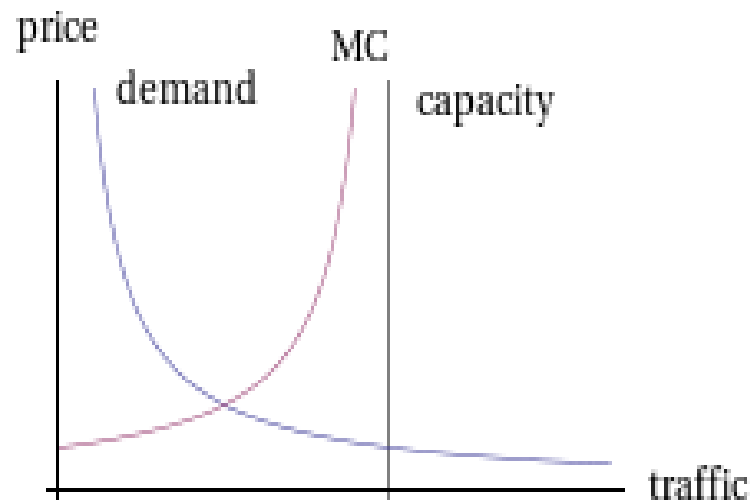
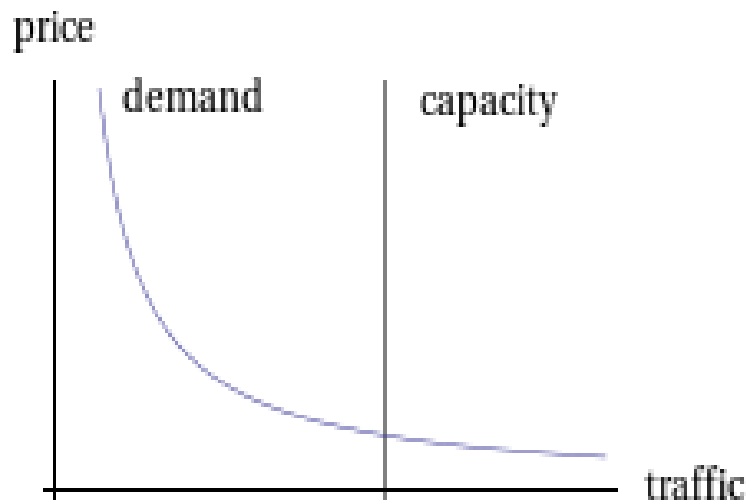
- Suppose you have a congestible resource (packets, streams, spectrum)
 - People value access to resource differently
 - Who should get in?
- One proposal: those with highest value for access
- Simple example
 - 3 users with values 10, 7, 5
 - Total user capacity is 2
 - Admit those with values of 10 and 7
- How do get people to truthfully reveal their values?
 - Must face some cost to revealing high value, i.e., a price
 - Individuals care about surplus = value – price
 - In this case, want to admit 10 and 7, exclude 5 which means price has to be between 7 and 5

Truthful revelation

- How can you get truthful revelation of value? Answer: run a Vickrey auction
- If there are k slots, then set price to be equal $k+1$ highest bid
- Why does setting price = bid of first excluded bidder work?
 - $\text{Payoff} = \text{Prob}[\text{bid} > \text{price}] [\text{value} - \text{price}]$
 - If $\text{value} > \text{price}$, I want to be admitted, which I can do by setting $\text{bid} = \text{value}$
 - If $\text{value} < \text{price}$, I don't want to be admitted, which is achieved by setting $\text{bid} = \text{value}$
- Bonus
 - This is the lowest price that actually clears the market
 - This pricing policy gives you the value of first excluded bidder, thus serves as appropriate guide to the value of capacity expansion.

Generalizations

- What if there is no sharp cutoff for capacity?
 - E.g., costs of congestion increase as channel approaches capacity
 - So system degrades gradually as capacity is approached
 - Maximize $\sum v_i x_i - c\left(\sum x_i\right)$
 - Optimal position is where value = marginal congestion cost



Cost recovery

- Congestion pricing is about network management; cost recovery is separate issue
 - Cost structure: fixed costs to build and maintain network, small usage sensitive cost on network operator, but potentially large usage-sensitive costs on users from congestion
 - Pricing structure: two part tariff – a fixed payment for fixed cost recovery and a variable payment for usage-sensitive costs
- Doesn't ISP have bad incentives to create congestion?
 - If ISP creates congestion, the willingness to pay for access goes down
 - If there is sufficient competition, then ISP has incentive to create optimal amount of congestion
 - In pure monopoly, ISP will generally want to extract profit from fixed payment, and use congestion pricing in order to create the most valuable network
 - In-between cases are ambiguous
- What is important is that users pay congestion charges, not that operator receives them
 - Someone else could get congestion charges (other users, charity, government, IETF, etc.)

Other objections

- Mental accounting costs
- People don't want to feel constrained
 - Computer should do the calculation
 - User should just indicate preferences for priority
 - “I want this movie right away”, “I want this movie in an hour”
- Actual accounting costs
 - Most of the gains come from relatively coarse pricing
 - High and low would help, 8 levels would likely be fine
 - Sampling would be fine
- Tiered access is a step in the right direction
 - This is, of course, available now
 - Benefit: simple accounting, cost: not all that flexible
- Who pays, sender or receiver?
 - Doesn't matter if there is a recharge mechanism, since can build in transport costs into price of service (“free shipping”)
 - Is an issue if recharge is infeasible and there is monopoly provider

INDEX project

INDEX project

Back in 1998-1999 we offered 128kbs ISDN service to about 70 Berkeley-affiliated people and tried different pricing policies

Bandwidth: easy to understand, users quite sensitive to (small) prices

Volume transmitted: confusion

Buyout: presented them with pricing menu at start of week, offered flat fee to buyout

Various mixtures: of above

Conclusions

80:20 rules: 20% of population uses 80% of bandwidth

Bandwidth pricing works in the sense that people will respond strongly to price incentives, even when prices are small

Obviously: demand for bandwidth depends on applications available and vice versa

People will pay a premium for unmetered use
