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?
  ▪ Payoff = Prob[bid > price] [value - price]
  ▪ If value > price, I want to be admitted, which I can do by setting bid = value
  ▪ If value < price, I don't want to be admitted, which is achieved by setting bid = 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
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.