

QoS and Internet User Welfare

WINE 2008

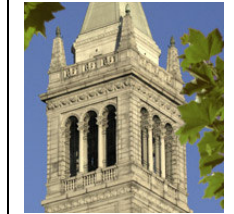


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12-19-08

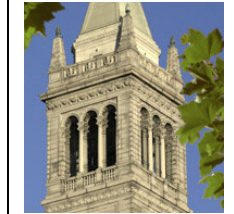
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Outline



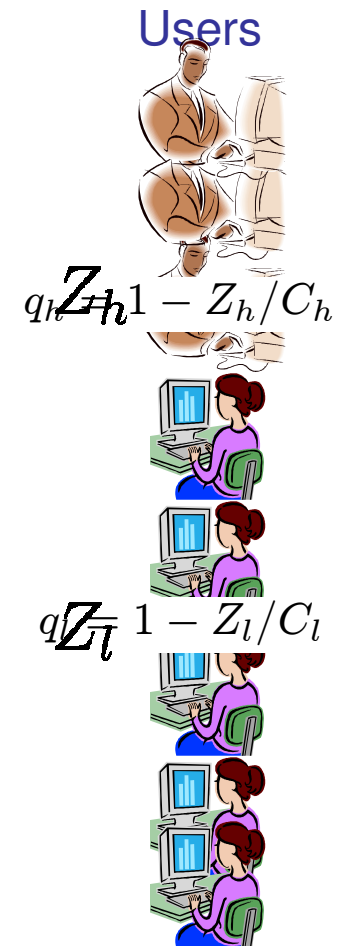
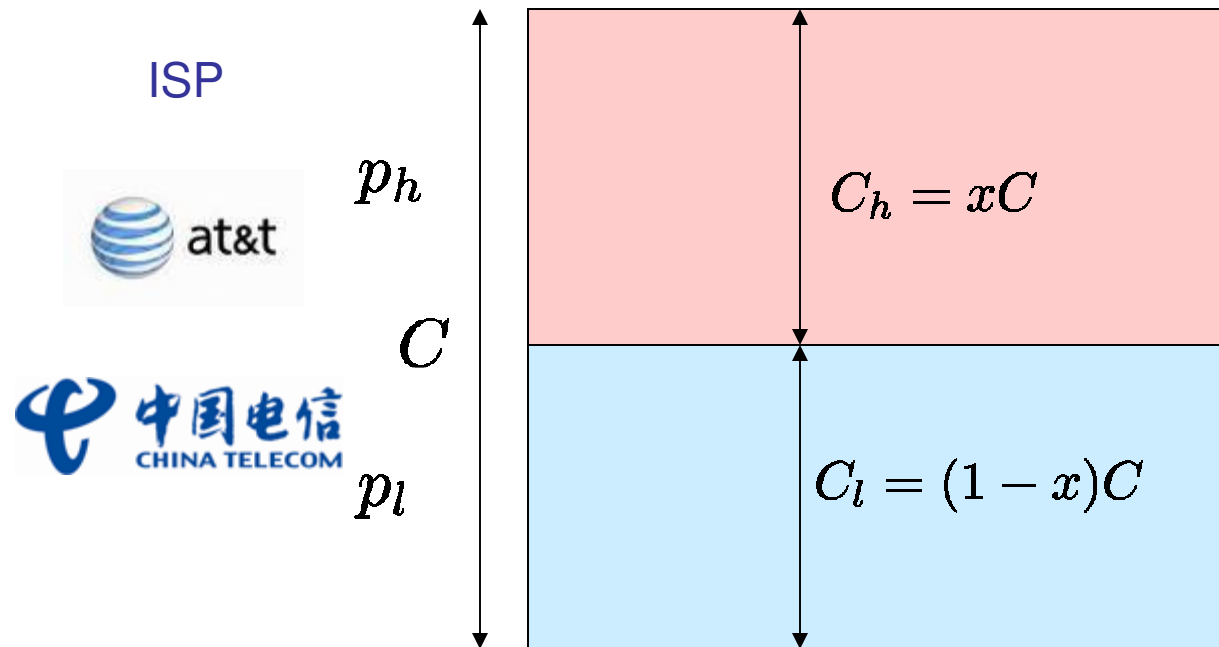
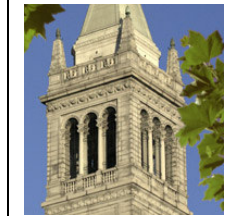
- Motivation
 - Why no Quality of Service (QoS)?
- Model
 - Monopolistic ISP
- Results
 - Regulations for social welfare
 - Connection to Network Neutrality
- Extension – Competing ISPs

QoS: Comparison of Results



- [Whinston, et al]: No social planner divides capacity
- [Gibbens, et al]: Competitive pricing is unstable
- Our Results
 - Social planner divides capacity
 - Equilibrium [even with competition] – stable pricing
- Why different results?
 - Capacity NOT fixed

Model – ISP Profit

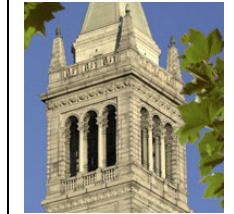


Objective: Maximize profit

$$\max_{C,x,p_l,p_h} \{p_l Z_l + p_h Z_h - \tau(C_l + C_h)\}$$

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Model – User Demand



Users

- Type θ
 - Willingness to pay
 - Quality requirement

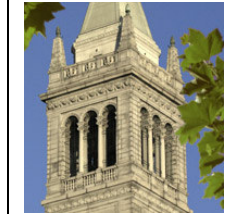
$$p_i < \theta \leq q_i$$

$$\text{User Utility: } U_\theta = (\theta - p)\mathcal{I}(q - \theta)$$

- Demand
 - N users
 - $\theta \rightarrow$ Uniform in $[0, 1]$

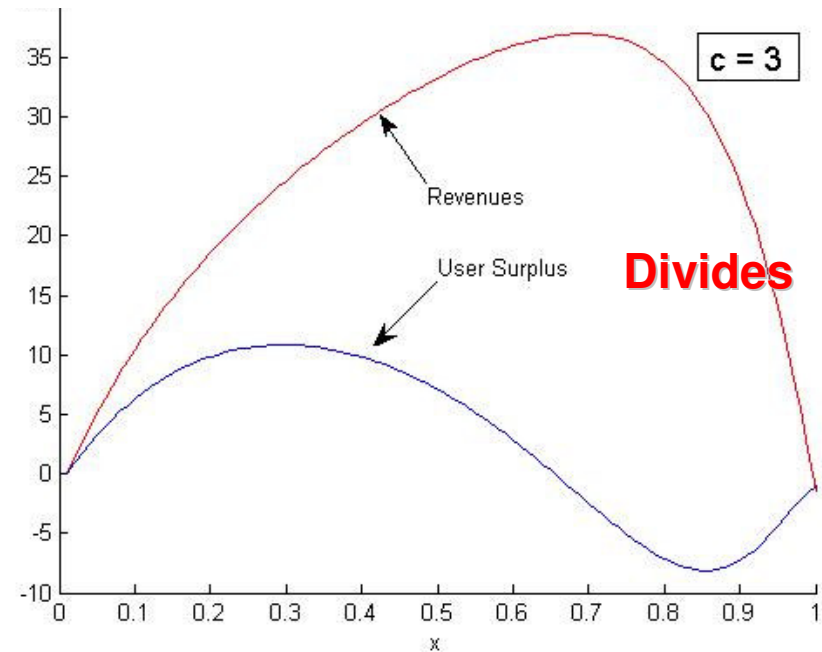
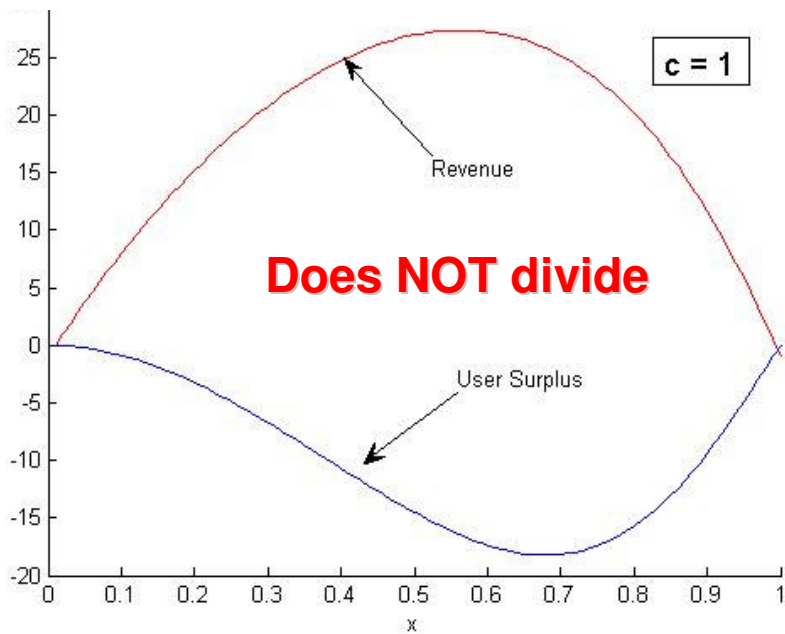
**Social Planner Objective:
Maximize Total User Utility**

Case 1: Fixed Capacity

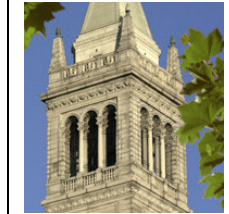


Capacity Fixed \rightarrow Does Social Planner divide?
It depends

Percent Change in Revenue and Welfare vs X

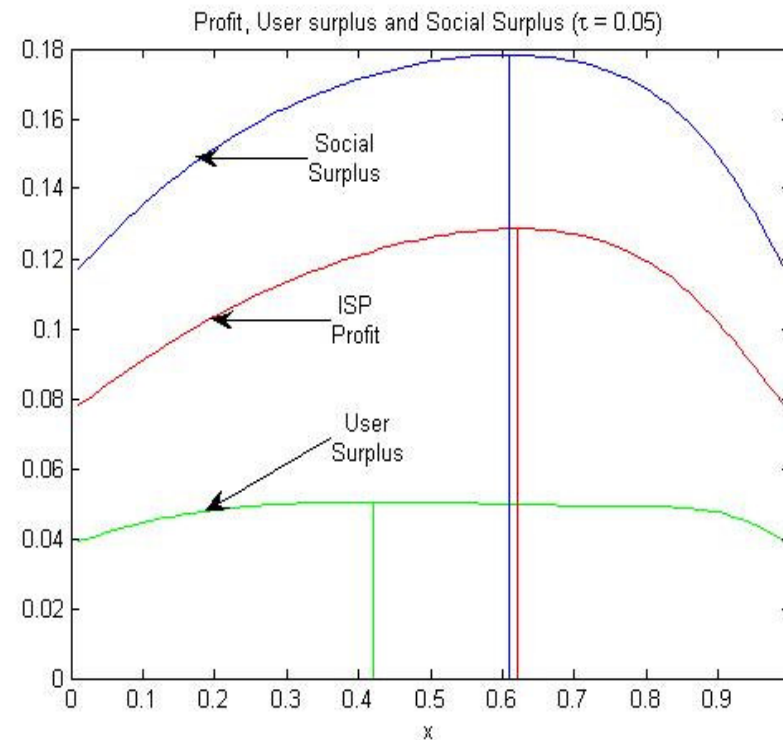


Case 2: Variable Capacity

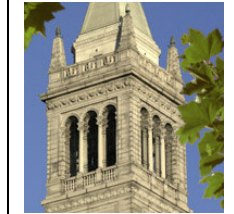


- For each x , ISP chooses $\max_{C, x, p_l, p_h} \{p_l Z_l + p_h Z_h - \tau(C_l + C_h)\}$
 - C
 - p_h and p_l

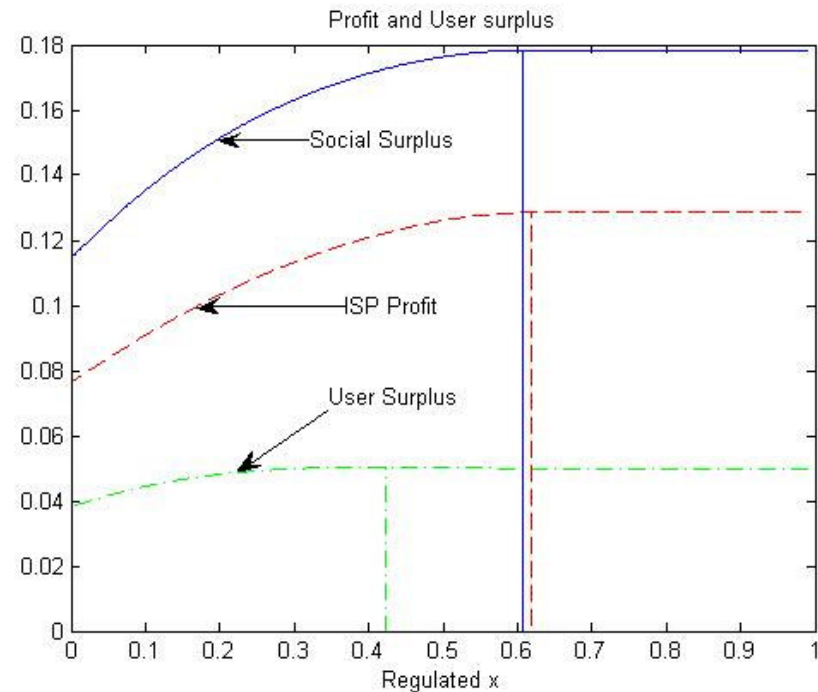
- Does Social Planner divide?
- Yes, she does!



Why regulate x ?

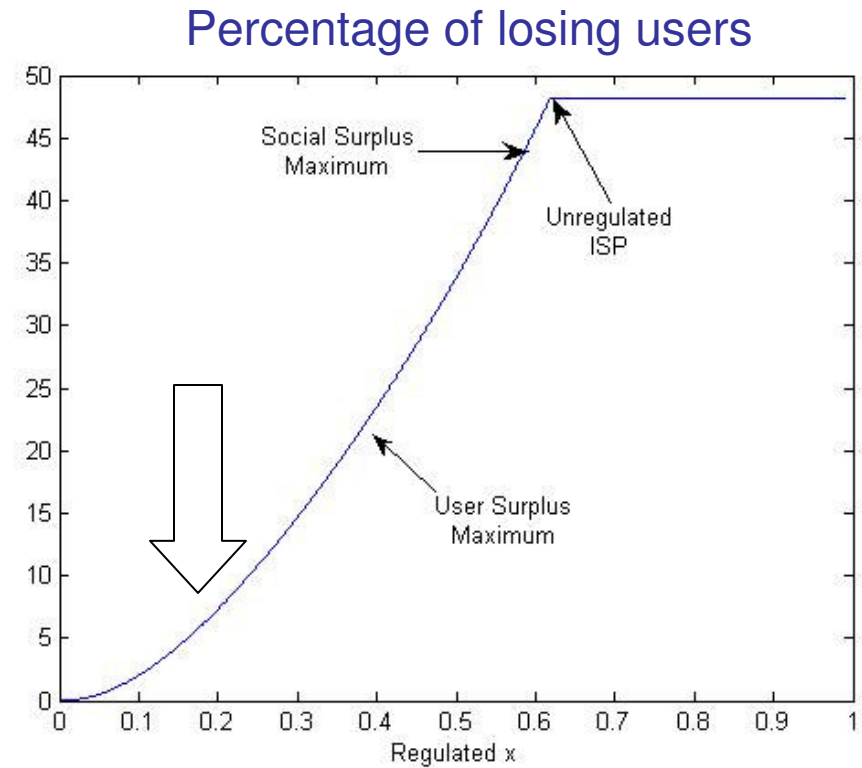
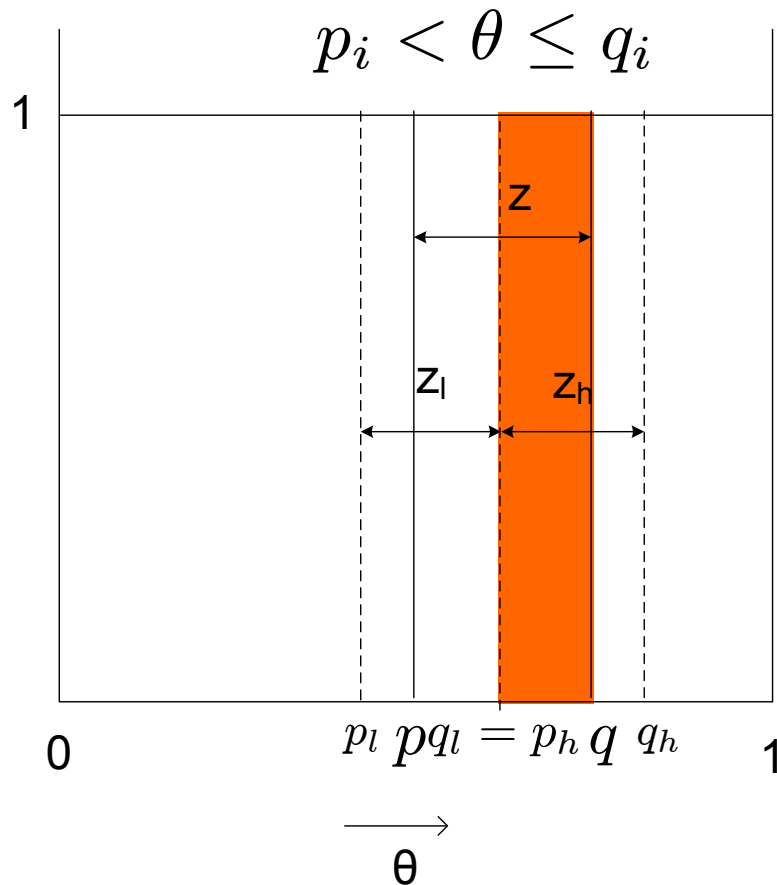
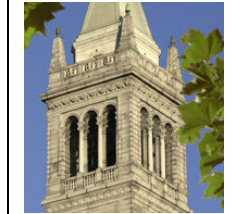


- x -rule: $x \leq \mathbf{x}$
- Why not C , p_h and p_l ?
 - Feasible*
 - Efficient
- How to choose \mathbf{x} ?
 - User surplus
 - Losers due to transition

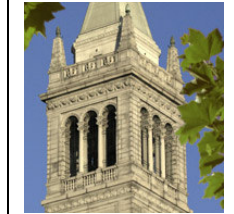


*Network Neutrality: Avoiding the Extremes - Nikhil Shetty, Galina Schwartz and Jean Walrand.

Users who lose due to transition

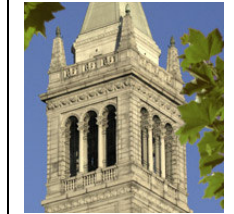


Connection to Network Neutrality



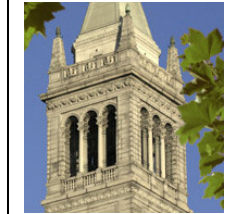
- Many dimensions of the debate
- Focus on multiple service classes only
- Dividing capacity is good but...
 - ... some users lose
 - Limit this number
- Assign property rights to a (small?) fraction x
 - ISP incentive to invest
 - Protect basic users

Conclusions



- Variable capacity affects QoS results
 - Divided Capacity → Higher user welfare
- Regulate share of premium capacity
 - Maximize user welfare
 - Limit unsatisfied users
 - Make transition politically palatable
- Stable pricing under Competition
 - Results in working paper
 - Regulation needed if number of ISPs is low

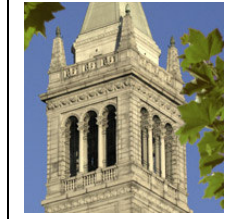
Thank you!



Questions?

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Competition



- Players: ISPs and users
- All actions observable
- Game
 - Stage 1: ISPs invest C
 - Stage 2: ISPs choose x
 - Stage 3.1: ISPs declare p
 - Stage 3.2: Market price \Rightarrow Minimum p declared in 3.1