

Economic Issues for the Internet

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Prof. Jeffrey K. MacKie-Mason

Dept. of Economics, School of Information and School of Public Policy

University of Michigan

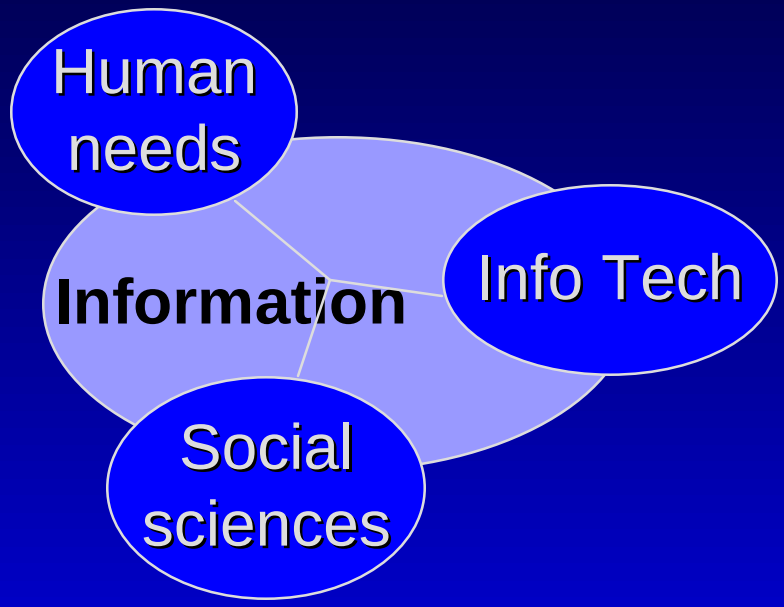
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Why economics?

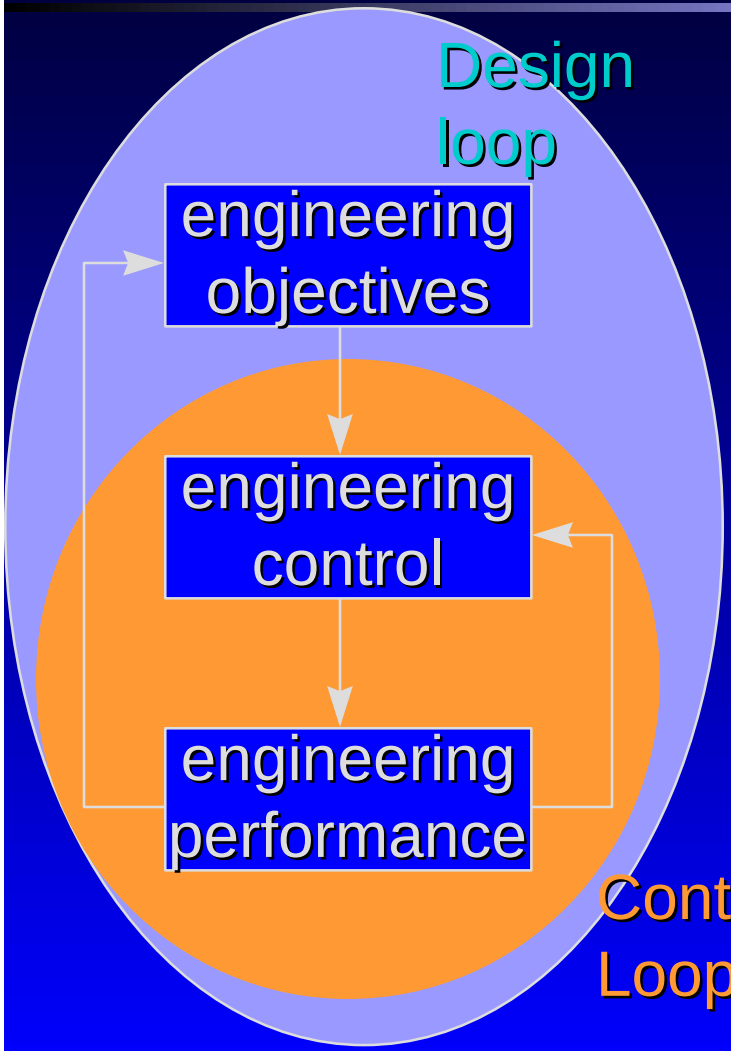
- Economics is concerned with the allocation of scarce resources
  - *describe* how allocation is occurring
  - *prescribe* how to do it better
- Better? According to whom?
  - User-centered valuation
  - “network only as good as its users think it is”
- How to get most value for users given technological and financial constraints?

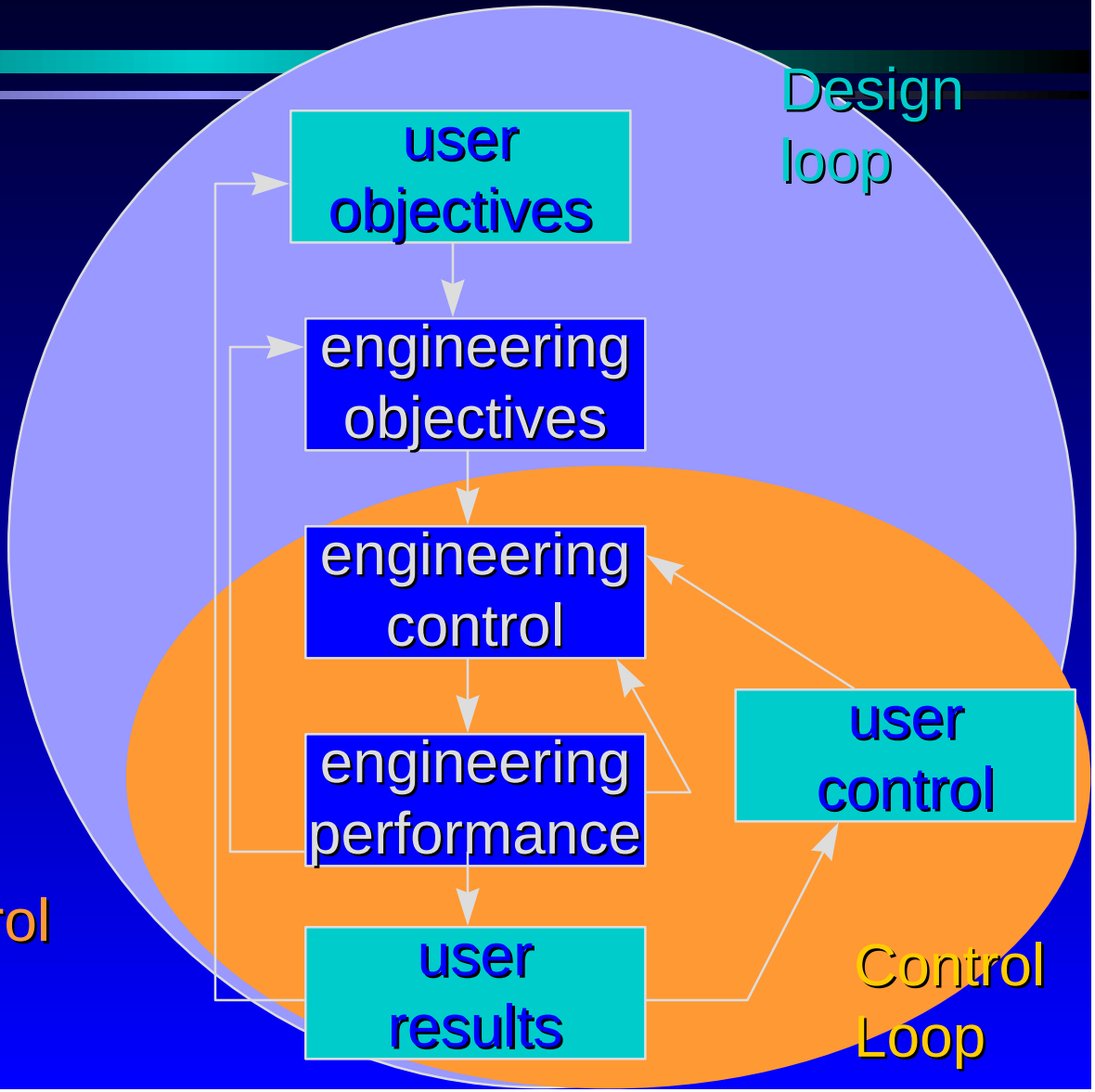
Keep the user in the loop

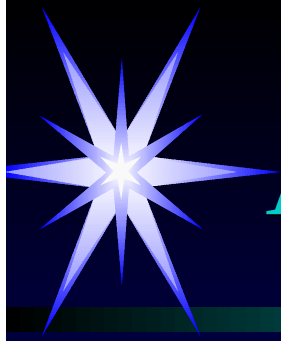
- Nexus:
- Example of human-oriented design:
  - decreasing costs of **silicon** and **sand** push the intelligence toward the periphery
  - at the periphery: the users -- *why treat users as dumb terminals instead of smart devices?*



Putting users into the feedback loop







Application: Congestion pricing

- Is the Internet going to collapse?
  No.
- Is it a great idea to charge for every packet?
  No.
- Is it a good idea to charge for *congestion*?
  Probably yes.
  - More generally, charge for different qualities of service
  - Users want different qualities, too expensive to provide premium quality for everyone

Why charge for congestion?

- Congestion is an intrinsic feature of shared-media facilities
  - Tautology: there must be *some* mechanism for allocating scarce resources when congested
    - first-come, first-served or other rationing schemes
    - throw money at it
    - or, *respond to user valuations*
- prices during congestion spells are a feedback (push-back) signal to users: includes them in the control loop

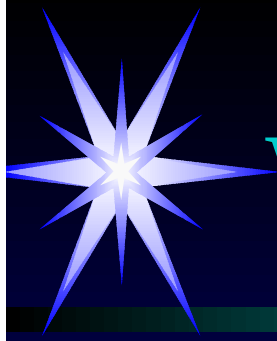
Is charging necessary?

- Congestion is with us
- We’re some distance from FTTB (fiber to the brainstem)
- Quality of service allocation is going forward, like it or not:
  - MCI/BT “limited access” backbone
  - Internet II
- How is bandwidth for video home to Mom going to be allocated under RSVP?



Happy opportunity, not a grim curse

- Including users in the feedback and resource allocation loop is simply good engineering practice
  - work with the available resources and intelligence to make the best system for the users
- It's a coherent, much practiced way to give users what they want, and make the Internet *the* Network of Networks
- It's going to happen anyway, somehow -- do you want the Bellheads to do it their way?



What else is scarce?

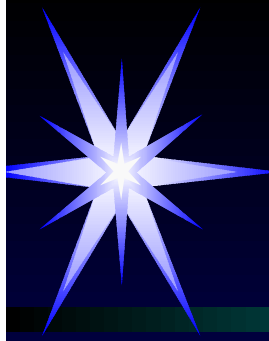
- Some domain names
- IP number and route advertisements
  - scalable routing and address space utilization sometimes require renumbering and other undesirable reallocations
  - use financial incentives rather than just persuasion and coercion (which don't scale well!)
  - Rekhter, Resnick and Bellovin 6/96 Internet Draft
- Links *between* domains of commercial influence
  - Clark's "regional pricing" and trans-Atlantic cables

Another issue: survivability

- Social (civilian and defense) reliance on information networks is increasing
- Disruption costs could be high
- IP is “weakly robust”
  - fixes itself, but not efficiently
  - no mechanism to approximate optimal re-routing
  - no mechanism to prioritize traffic

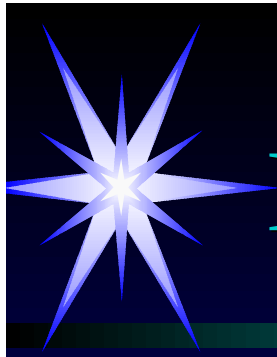
Market mechanisms for survivability

- Economies are “strongly robust” -- prices are the shadow values of a constrained optimization problem
  - Market is a de-centralized mechanism for discovering new shadow values when conditions change, and configuring transactions accordingly
  - Traffic with highest value will get priority; links with extra capacity will attract use (low price)
- DARPA funding projects on computational smart markets for dynamic network robustness



Other interesting issues

- Economics of information:
  - silicon and sand are getting cheap, so we now have “info glut”
  - but creativity and quality authorship are still scarce
  - ability to filter / evaluate / select requires scarce human time
- There is no Moore’s Law for neurons
  - we need to engineer information systems that make better cocktail parties!



Internet Telephony

- IP's intrinsic cost advantage is modest
  - telephony burstiness about 2:1 so potential IP cost is 50% of voice circuit
  - but IP has about 17% in-band overhead, so IP about 60% of the cost (yadda, yadda)
  - cost decreases so rapid that static 60% cost ratio is not the key factor
- regulatory anachronisms drive the competition
  - rather than deregulate telephony faster, might start to regulate IP services to "level the playing field"