CS551
Integrated and Differentiated Services

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http://merlot.usc.edu/cs551-f12

What's Next: Integrated Services

- Integrated services
  - resource reservations (Internet: RSVP)
  - guaranteed or probabilistic bandwidth/delay
- Pros:
  - good match for real-time traffic (e.g., VOIP)
  - prefect for VPNs (ISPs can sell "virtual pipes")
  - make the most use out of your bandwidth
- Cons:
  - too much state for backbone routers
  - difficult policy issues between AS's?

    $\Rightarrow$ not widely deployed

What's Next: Differentiated Services

- Differentiated services
  - assumes some overprovisioning
  - very simple service model
    - best-effort and preferred (better-than-best-effort)
    - or in and out (best-effort and less-than-best-effort)
- Pros:
  - easy to implement and fast (no per-flow state)
  - ISPs can charge extra for preferred
- Cons:
  - no guarantees

CS551
Fundamental Design Issues

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Key Ideas

- Do we need to extend the Internet service model (currently best effort)?
  - Reservations, admission control, etc, or
  - Overprovision and keep best effort
- How do we even study this question?
- Simple model, very high level view
  - Asks fundamental questions
  - Helps guide the thinking for a very hard question

Model: Utility and Efficacy

- Does the network make users happy?
- Define U(j) be the utility delivered to the jth user
  - U(j) maps the network's performance to the user's level of happiness
  - For example, higher bandwidth delivered to a video application (up to a point) makes the user happier
  - Similarly, lower delay delivered to application makes user happier
- Goal of network is to maximize
  - ... the sum of all U(j)s (the efficacy, denoted by V)

More Bandwidth or New Service Model?

- In a best-effort network, can increase bandwidth to increase efficacy
- Or, for the same bandwidth, introduce new services matched to application needs
  - ... and increase efficacy that way
- Key question: what's the relative cost of adding bandwidth and adding new services
  - Shenker: always better to add new services
    - makes better use of available bandwidth
    - but cost of adding new services hard to estimate

Other Considerations

- Do separate networks for different applications provide higher efficacy?
  - No. A single network can always use leftover bandwidth to increase efficacy
- Note: increasing efficacy does not mean increasing everyone's utility
- Service models must map application requirements
  - Otherwise, none of these arguments holds

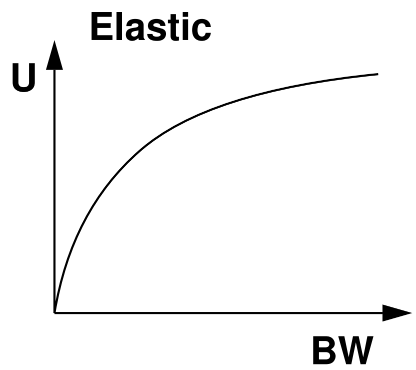
Implicit vs. Explicit Service Request

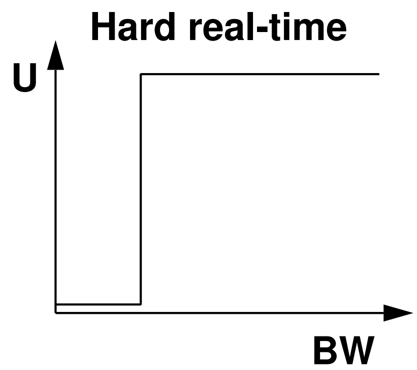
- Should applications explicitly request service, or should the network determine service to deliver?
- Implicit doable if number of services is small and well known and stable (e.g., port number)
  - Need to embed application knowledge inside the network (BAD!)
- Explicit supports larger variety of services but incentives needed so all do not request highest service
  - Applications must know what they want!
  - Pricing, accounting and billing: these are hard
- Stable service model needed so apps know what to request
  - Major coordination effort (imagine changing IP or Ethernet..)

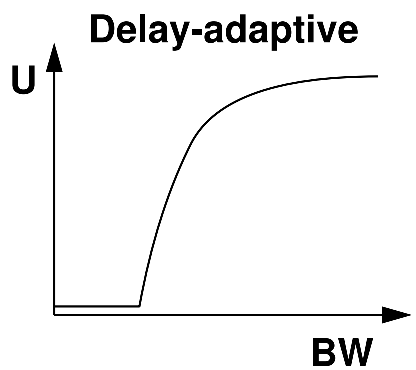
Admission Control?

- Overload: a network is overloaded if by removing a flow would increase V even though there are fewer flows
- If V(n) does not continue to increase as n goes to infinity, then we either need admission control or over-provisioning
- Best Effort never overloads (or does it?)

Utility Curve Shapes







- If convex near origin, then need admission control

Over-provisioning

- Works for "normal users" because need to overprovision by a small amount
- Over-provisioning for "leading edge" users is hard because these consume several orders of magnitude more than normal users
- Internet will be provisioned to rarely block normal users, but will block leading edge users frequently

Summary

- Internet should extend its service model
  - Service should be explicitly requested by applications
  - Service model should incorporate admission control
  - Abstract formulation of maximizing efficacy
- Digital convergency: *Integrated Services*
  - Data network
  - Telephone network
  - Cable network

    $\Rightarrow$ under one IP