Integrated and Differentiated Services

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resource reservations (Internet: RSVP)

Pros:

- prefect for VPNs (ISPs can sell "virtual pipes")

Cons:

- too much state for backbone routers
- difficult policy issues between AS's?

What's Next: Integrated Services

Best-effort and preferred (better-than-best-effort)

Pros:

- ISPs can charge extra for preferred
- no guarantees

Cons:

- easy to implement and fast (no per-flow state)
- no fundamental questions
- does the network make users happy?

What's Next: Differentiated Services

Model: Utility and Efficiency

Define $U(j)$ be the utility delivered to the $j$th user

For example, higher bandwidth delivered to a video

Does the network make users happy?

U(j) maps the network's performance to the user's level of

happiness (e.g., makes the user happier)

$V$ is the sum of all $U(j)$'s (the efficiency, denoted by $V$)

Goal of network is to maximize

user happiness

Shenker's paper: lower delay delivered to application makes

application (up to a point) make the user happier

for example, higher bandwidth delivered to a video

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Does the network make users happy?
In a best-effort network, can increase bandwidth by

- Over-provisioning, i.e., renting more than normal
- Increasing efficiency does not mean increasing
- More efficient network can serve use higher bandwidth

Otherwise, none of these arguments hold.

Service models must map application requirements

- Need to embed application knowledge inside the network

Elastic

- If convex near origin, then
- Need admission control

Effort

- If over-provisioned (or over-allocated),
- Then we either need admission control or over-provisioning

- If convex near origin, then
- Need admission control

Hard real-time

- If bandwidth needed is small and well known
- Implicit allocation too service-specific to deliver
- Over-provisioning too expensive to justify
- Should applications explicitly request service, or should

- Best effort never overloads (or does it?)
- Internet will be professional to re-route normal users, but
- These consume several orders of magnitude more than normal
- Works for "normal users" because need to over-provision by a small margin

- Need admission control

- For "normal users" because need to over-provision by a small margin

- Can switch service model needed to 40Gbps when we need to
- Provide guarantees and billing: these are hard
- Application must know how they want
- Need additional service, so do not need higher service

- If convex near origin, then
- Need admission control

Other Considerations

Key question: what’s the relative cost of adding bandwidth and adding new services

- Or, for the same bandwidth, introduce new services matched to application needs

- Need to embed application knowledge inside the network

Use explicit if number of services is small and well known (e.g., port number)

- Applications must know what they want!

- Implicit supports larger variety of services but incentives

- Pricing, accounting and billing: these are hard

- Major coordination effort (imagine changing IP or Ethernet...)

- Stable service model needed so all do not request highest service

- Overload: a network is overloaded if 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?)

- If convex near origin, then
- Need admission control

- Works for "normal users" because need to over-provision by a small margin
Service should be explicitly requested by applications.

Internet should extend its service model.

Service model should incorporate admission control.

Data network

Digital convergence: Integrated Services

Abstract formulation of maximizing efficacy

Service model should incorporate admission control.

Service should be explicitly requested by applications.

Internet should extend its service model.