Conclusions

- Major barrier to service-level interconnection is coordination
- Need a coordinator – an overlay
- Network Neutrality: justified
- Government could lead the way
Three Levels of Interconnection

- Application Level
- Service Level
- Packet Level
Structure of Talk

- Narrowing the problem: video conferencing
- The stakes
- How stakeholders may solve the problem
- Government’s role
High Quality Video Conferencing May Help Drive QoS

- Widespread VC foreseeable
- Needs considerable bandwidth
  - Could press existing network capacity
- HQVC has a money flow that helps answer “Who pays for the QoS”?
- QoS = Lack of jitter, lack of loss, low latency
Non-Internet Video Conferencing

- Multi-billion dollar industry
- Hard-wired conference rooms
- Private IP network or ISDN
- Dependable; good video quality
- Monthly costs are US$ thousands
- *But can’t conference with everyone you want*
Internet-Based Video Conferencing

- WebEx, Skype, NetMeeting
- Connect from anywhere
  - Another company, a laptop on the road
- Much cheaper
- But undependable
Needed: Best of Both

- Widely available
  - Over the Internet
- High-quality & dependable
  - Quality of HDTV
Interconnection Is Lacking

- There is no good QoS across ISP boundaries
- It is not a technical problem
- It is a problem of coordination of ISPs
Stakeholders’ Interests

- **Customer**
  - Cannot sacrifice reliability, security

- **Access ISP**
  - Offering profitable HQVC-related services
    - Vertical integration
  - Offering HQVC to many points

- **Backbone ISP**
  - Profiting from carrying high-QoS traffic
Stakeholders’ Interests (2)

- Application Provider
  - Profit
  - Having QoS among many points

- Regulator
  - Avoiding inefficiencies we will discuss
Possible Scenarios

- ISPs *self-organize*
- App providers deal *individually* with ISPs
- Overlay *coordinates*
ISPs self-organize

- Currently unorganized
  - No industry-wide agreement on QoS
  - No standards / coordination initiatives
  - Money is left on table
- Need lots of arrangements
  - Each ISP negotiates with all/most of its neighbors
ISPs self-organize (cont'd)

- Complex task to coordinate
  - Unclear compensation schemes
    - Pay by quantity? Pay by congestion?
  - Conflicting internal policies to optimize

- End-to-end QoS unlikely
  - More than agreeing to a standard – manage complex money flows
  - Possible fragmentation
App Providers Deal with ISPs

- High incentives
  - “Face” to the customers
    - Takes blame if low quality
    - No need to contact ISP for separate QoS
  - Possible strategic edge
    - Better service than competition
    - Co-market “bundles” with selected access ISPs
App Providers: Packet Flow

"WebEx" packet, high QoS!
App Providers: Money Flow
App Providers: Issues

- Still very high costs to coordinate
  - Critical to partner with large ISPs
- App providers want exclusivity
  - Fragmentation possible
- Small app providers may be left out
  - High costs, no bulk discounts by ISPs
- Doubtful many app providers can coordinate a majority of ISPs
Reality Check

- Getting ISPs to self-organize is hard
- Getting App Providers to each organize with every ISP is hard
- Potential role for an overlay as a coordinator
Overlay Drives Coordination

- Trusted 3rd party
- Overlay manages:
  - money flow
  - traffic through preferred ISPs
- Who pays whom:
  - Users pay APs
  - APs pay overlay
  - Overlay pays ISPs

Business Arrangements
Case Study - Internap

- Lease bandwidth from backbone ISPs
- Provide very high dependability by avoiding ISPs with congestion
Internap Congestion Routing

But Internap doesn't offer last-mile QoS
Overlay Benefits

- For ISPs:
  - Can remain a “cloud” to other ISPs
  - Coordinate with one overlay
    - Lower cost than self-organizing

- For App Providers:
  - Large/small providers can get SLA
  - Deal only with overlay – no ISP

- For consumers:
  - Same way to sign up / get service
  - Extra fees, if any, paid only to app provider
  - Widely availability - can reach more users
## Summary of Scenarios

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<tr>
<th></th>
<th>ISPs</th>
<th>App Providers</th>
<th>Overlay</th>
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<td>Scalability for New Aps</td>
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Overlay: A Natural Monopoly?

- High sunk cost: putting a system of coordination in place
- Low marginal cost: operating, adding new ISPs
- Network externalities; hard to start up
- But after it is done once, others may learn from example
Network Neutrality

- QoS is new revenue opportunity for ISPs
- If monopoly, overlay should be neutral for QoS traffic
  - More enforceable
Network Neutrality (cont’d)

- New problem: pro-QoS discrimination
  - ISPs degrade non-QoS traffic on purpose
  - Requires regulation?
Government Initiates Overlay

- Establish functional guidelines for overlay
- Oversee development of overlay
- Provide seed money
Conclusions

- Major barrier to service-level interconnection is coordination
- Need a coordinator – an overlay
- Network Neutrality: justified
- Government could lead the way
An Overlay is a set of servers deployed across the Internet that:

a) provide some sort of infrastructure to one (or ideally several) applications,

b) in some way take responsibility for the forwarding and handling of application data in ways that are different from or in competition with what is part of the basic Internet,

c) are operated in an organized and coherent way by third parties (which may include collections of end-users) to provide a well-understood service that is infrastructure-like, but,

d) are not thought of as part of the basic Internet.