The Use of ATM Quality of Service to Support IP over ATM

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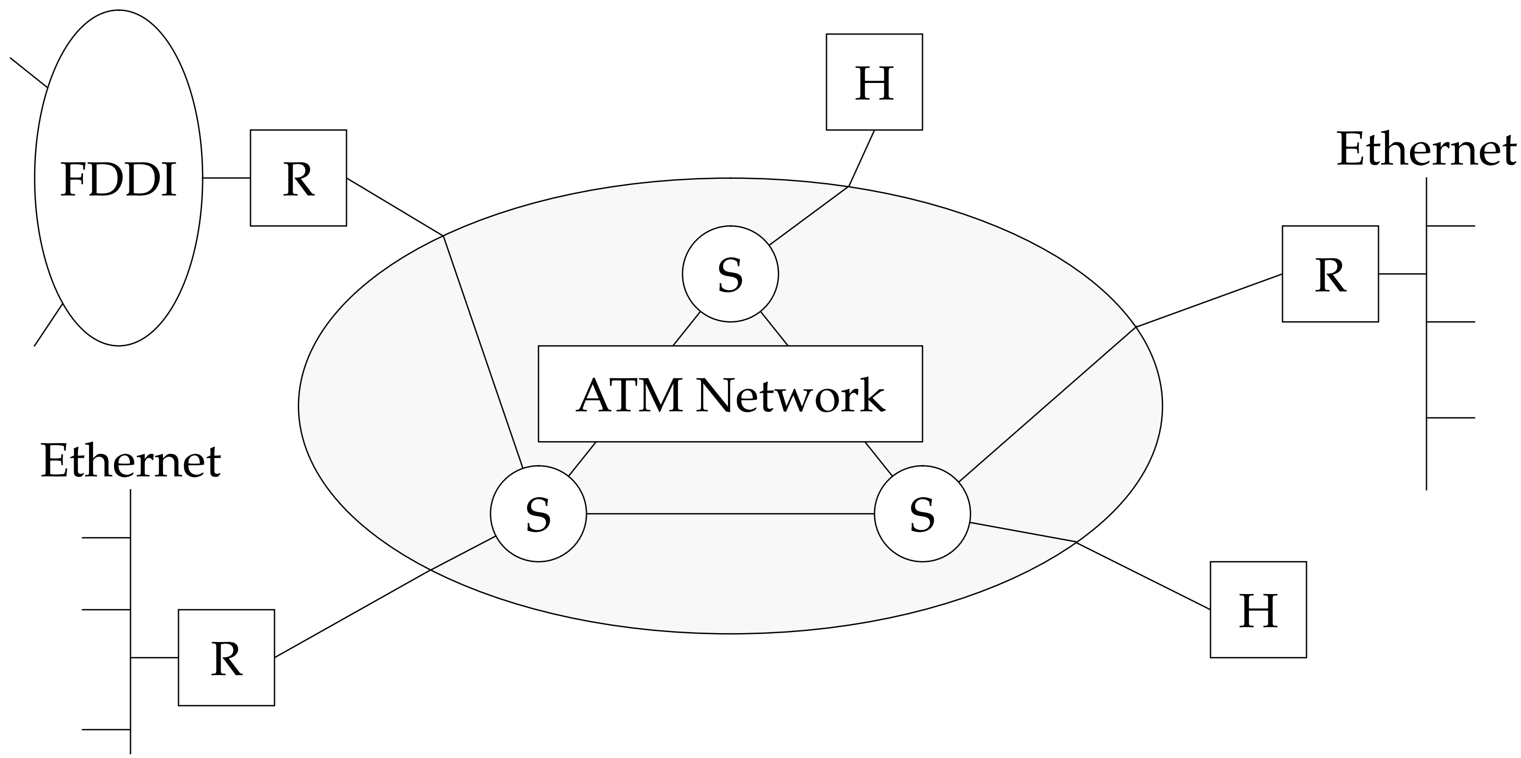
Outline

- Introduction
- Using ATM QOS for IP conversations
- Multiplexing
- Virtual circuit management
- Implementation and Evaluation
- Summary

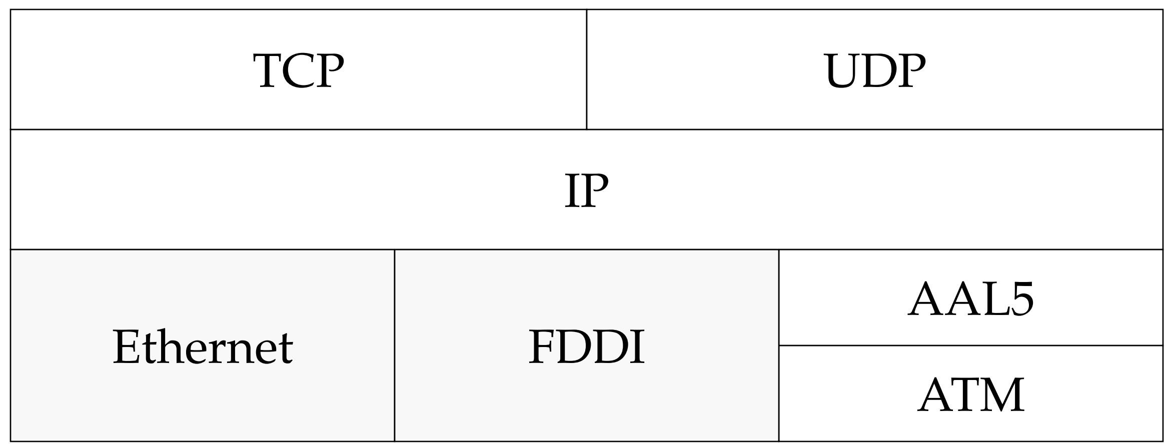
Environment: A Heterogeneous IP Internet



ATM network provides performance guarantees

Internetwork carries a mix of data and multimedia traffic

IP over ATM



IP layer uses ATM protocol stack as a datalink layer

Many commercial and research implementations exist

Can we use ATM QOS to improve performance?

Research Issues

Using ATM Virtual Circuits for IP

- How to map a stream of IP datagrams onto a virtual circuit?
- What QOS requirements do IP conversations have?

Multiplexing

- How and when should multiple conversations share a virtual circuit?

Virtual Circuit Management

- When should virtual circuits be created and torn down?

Mapping IP Datagrams onto a Virtual Circuit

"IP Conversation"

- A stream of related IP datagrams between common endpoints with some definable set of QOS parameters
- Hosts and routers use protocol headers to determine conversations
- Packets of a conversations travel over a single ATM virtual circuit

For example:

- All packets for a given `telnet` connection
- All NFS packets between a client and its server
- All ICMP messages between a host pair

Determination of Requirements

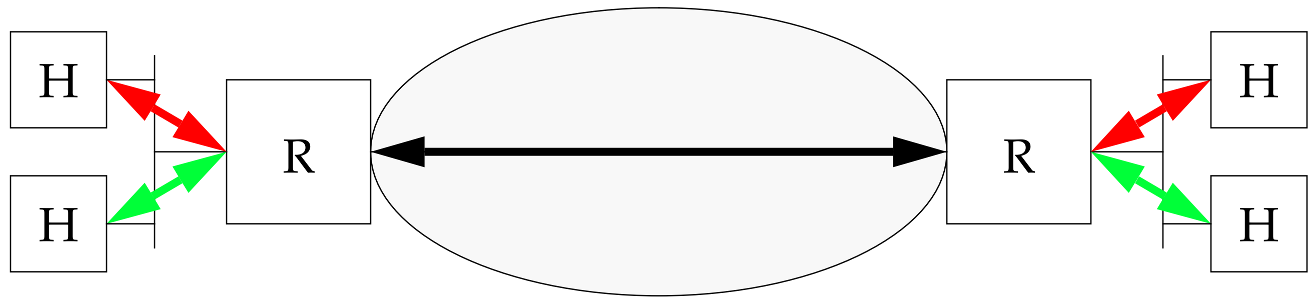
- Pre-defined per application
  - For well-known applications (e.g. `telnet`)
- Monitoring traffic
  - Adapt to bandwidth requirements (e.g. variable-bitrate video)
- Explicit signalling
  - In-band (e.g. IP options)
  - Out-of-band with a signalling protocol (e.g. RCAP, RSVP)

Multiplexing with QOS Considerations

Tradeoff

- Protection of individual IP conversations
- Increased utilization of reserved resources due to statistical multiplexing

Virtual Circuit Per Router Pair



All traffic between a pair of routers routed over same virtual circuit

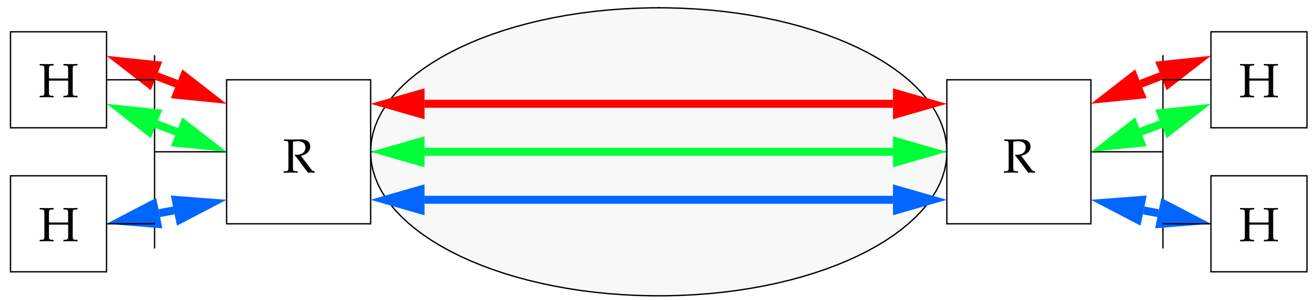
Statistical multiplexing of conversations over virtual circuit

No protection among conversations sharing a router pair

Uses:

- Low-bitrate or bursty traffic (ICMP)
- Background best-effort traffic (electronic mail)

Virtual Circuit Per Conversation



Each IP conversation seen by a router uses a separate virtual circuit

IP conversations protected from each other over ATM subnet

No statistical multiplexing gain within virtual circuit

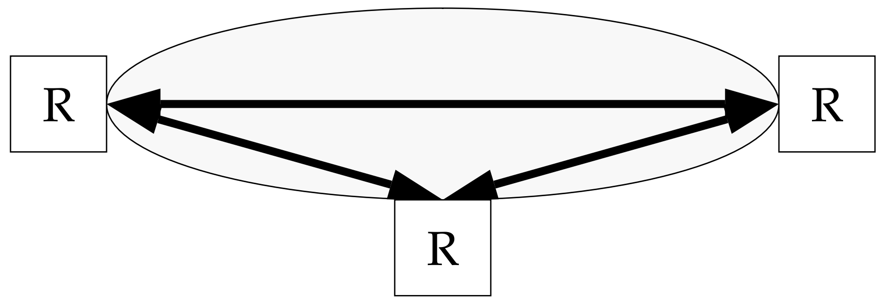
Uses:

- Real-time video
- Interactive file transfer

Virtual Circuit Management with QOS Considerations

- Paradigm shift: ATM connections vs. IP datagrams
  - When to set up and tear down connections for datagrams?
- Tradeoff
  - Long-lived virtual circuits: Tie up resources
  - Short-lived virtual circuits: Connection setup latency and processing

Permanent Virtual Circuits



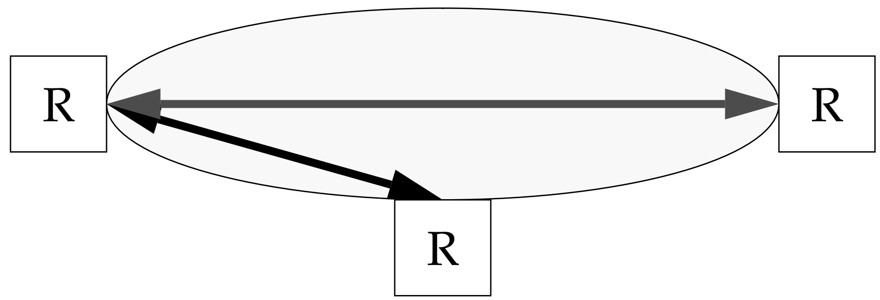
No connection setup latency

Resources always reserved

Not flexible enough to handle changes in load

Scalability a problem: $O(n^2)$ connections and resources

Switched Virtual Circuits



Establish virtual circuits on demand

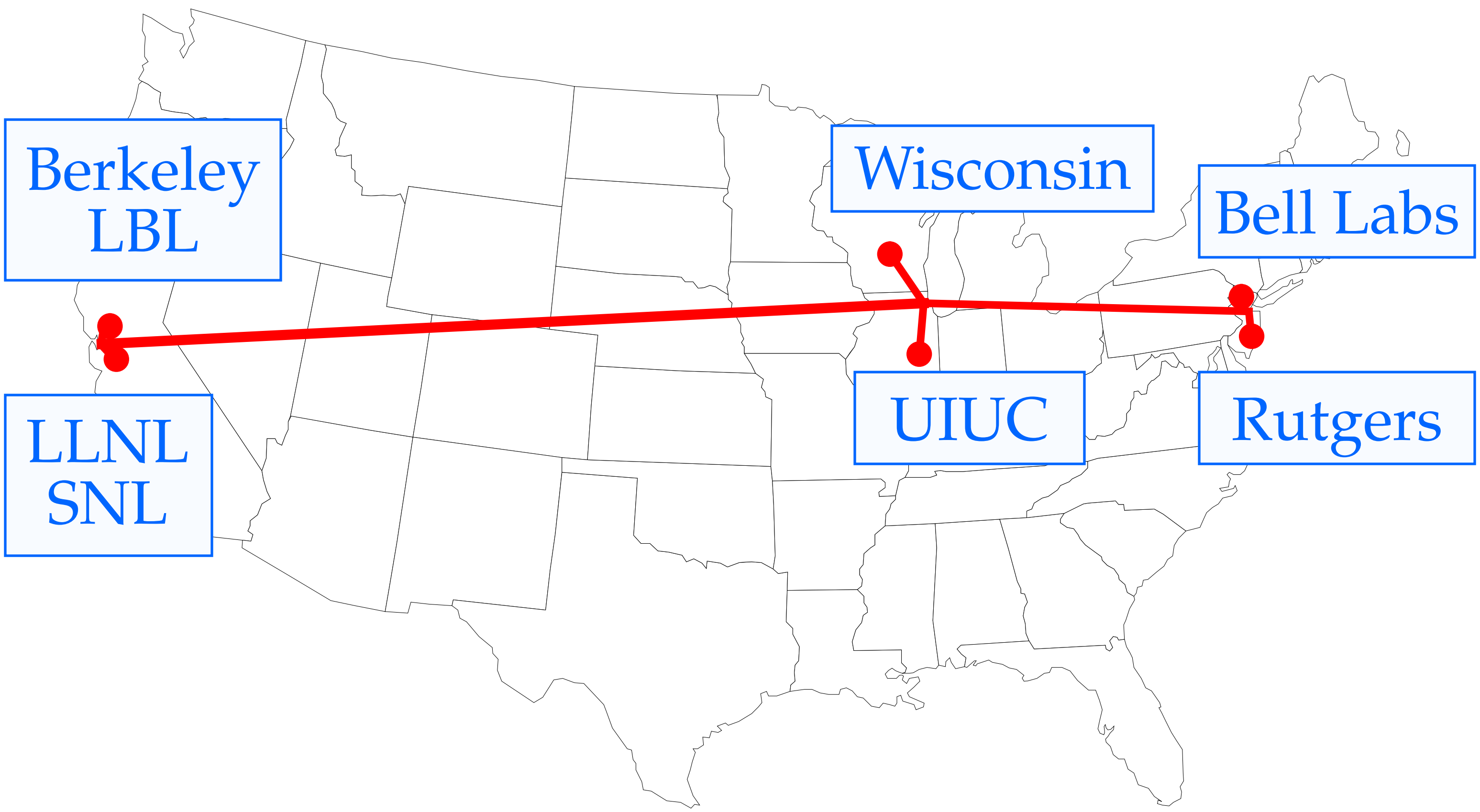
Tear down connections when not used

Connection setup latency incurred

- For first packet of conversation
- For other packets if SVC closed too early

Enhancement: connection caching for other IP conversations

Implementation and Evaluation

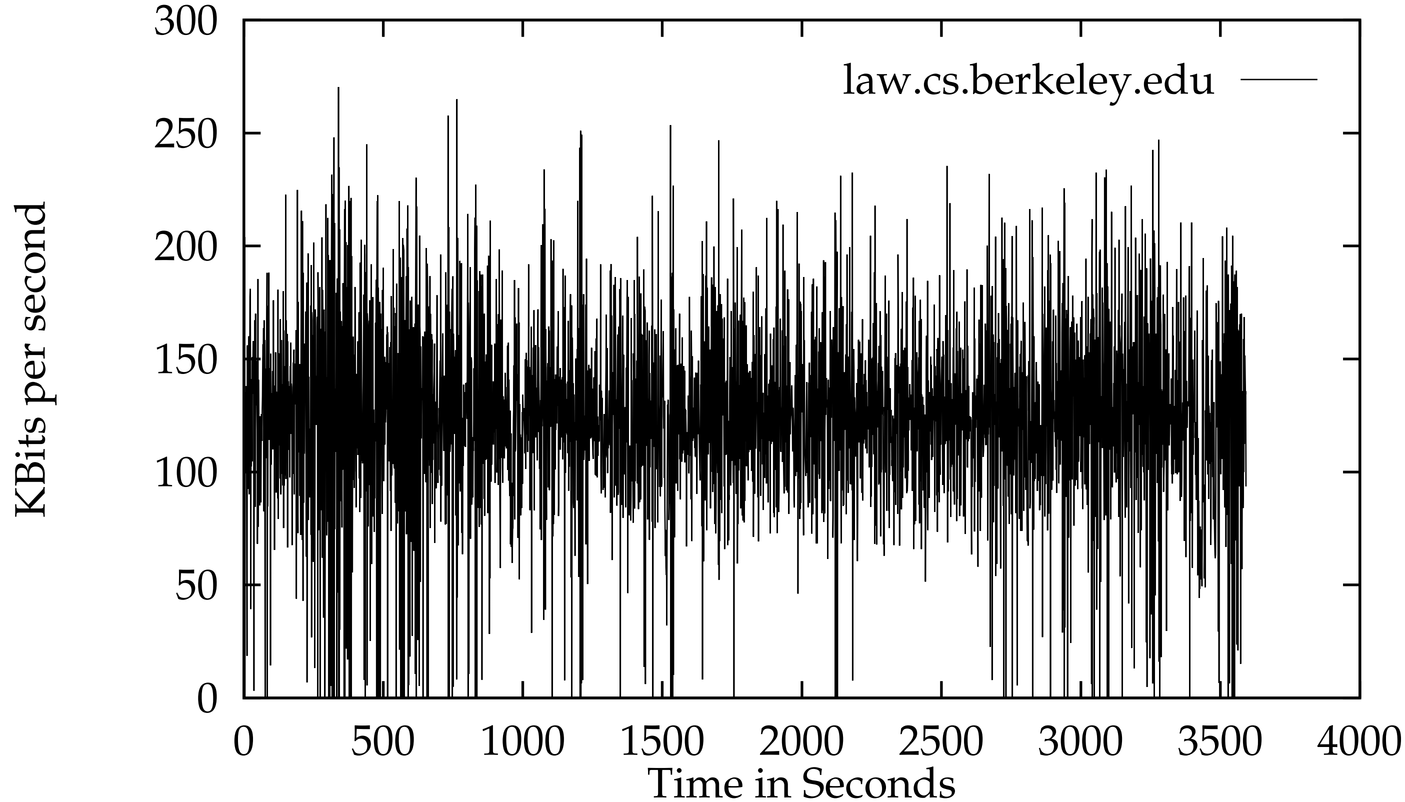


XUNET II: A wide-area ATM backbone (DS-3 between FDDI)

Completed Work

- MBONE Measurements
  - Video—`nv`
  - Audio—`vat`
  - Image distribution—`imm`
- XUNET IP driver modified to distinguish IP conversations
  - All TCP connections map to unique virtual circuits
  - All UDP streams map to unique virtual circuits
- XUNET IP over ATM service enhanced to use SVCs
  - Virtual circuits created on demand
  - Fixed idle timeout

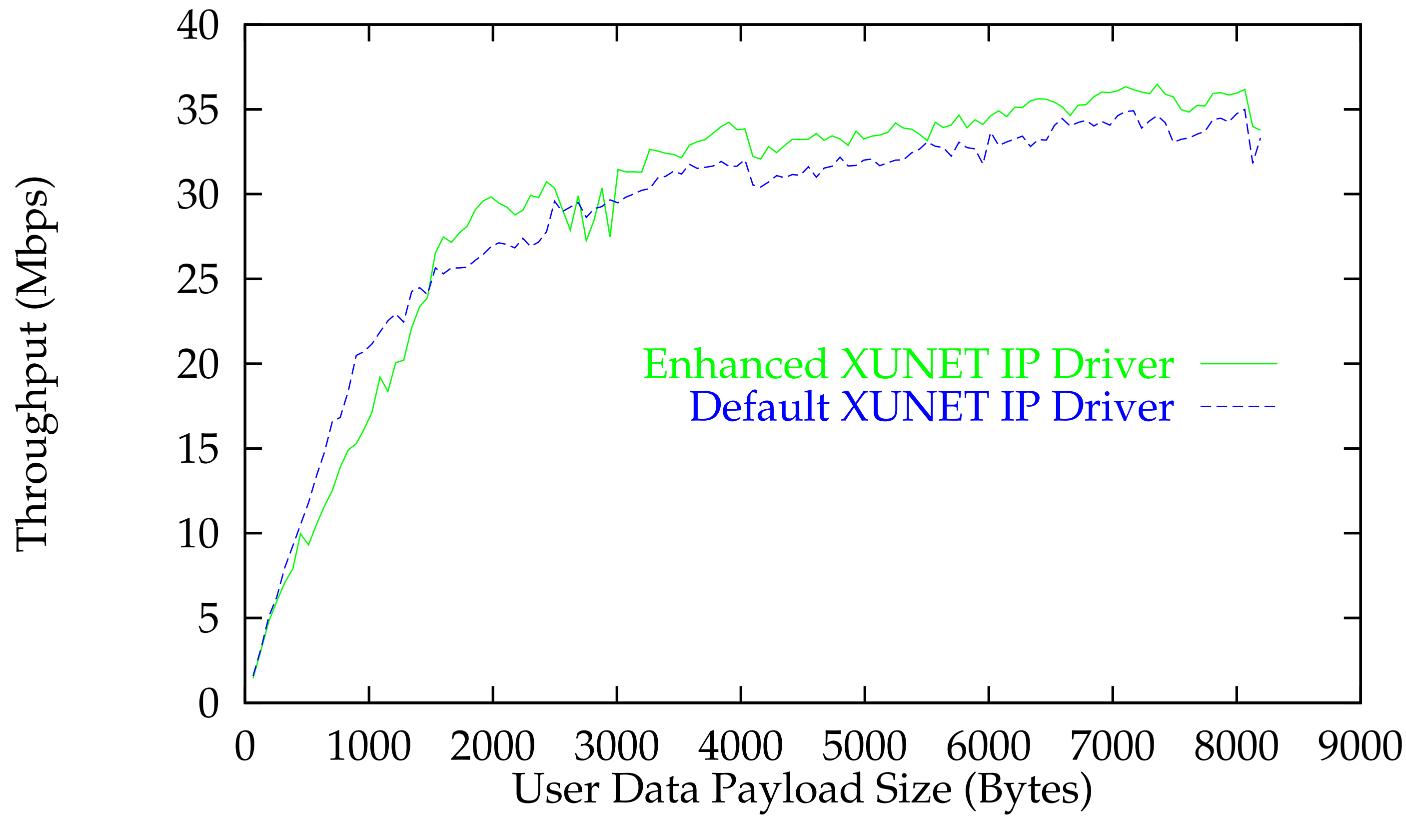
Video Bitrate (nv 128 Kbps)



Average bitrate (one-second samples) 115 Kbps

Peak bitrate (one-second samples) 270 Kbps

XUNET Router TCP Throughput



Preliminary measurements show no performance degradation

Work in Progress

- Obtain QOS-guaranteed virtual circuits over XUNET
  - Scheduling disciplines
  - Signalling support
- Formulate IP over ATM strategies
  - Mapping from IP conversation(s) to QOS-guaranteed virtual circuit
  - Multiplexing policy
  - Virtual circuit setup and teardown policy

Evaluation of Strategies

Performance for IP conversations

- End-to-end latency
- Throughput
- Setup latency

Overall network performance

- Utilization
- Efficiency and over head
- Best-effort performance

Summary

- Idea: Use QOS guarantees for an IP-over-ATM service
  - Use of virtual circuits with QOS parameters to carry IP data
  - Multiplexing
  - Virtual circuit use and management
- Implementation in progress on XUNET II
- Evaluate various strategies
  - Performance of individual conversations
  - Performance of network as a whole