

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

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Outline

Introduction

Using ATM QoS for IP conversations

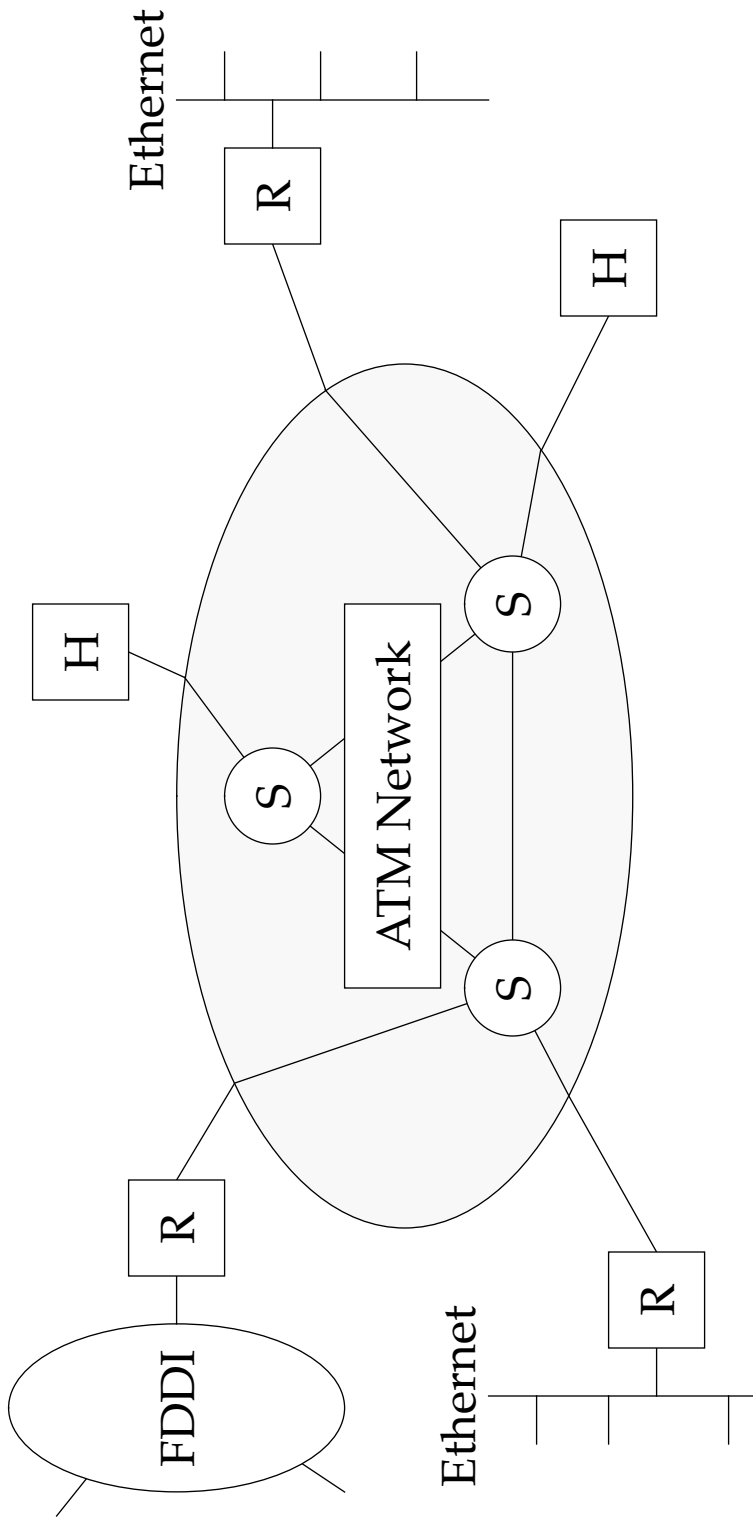
Multiplexing

Virtual circuit management

Implementation and Evaluation

Summary

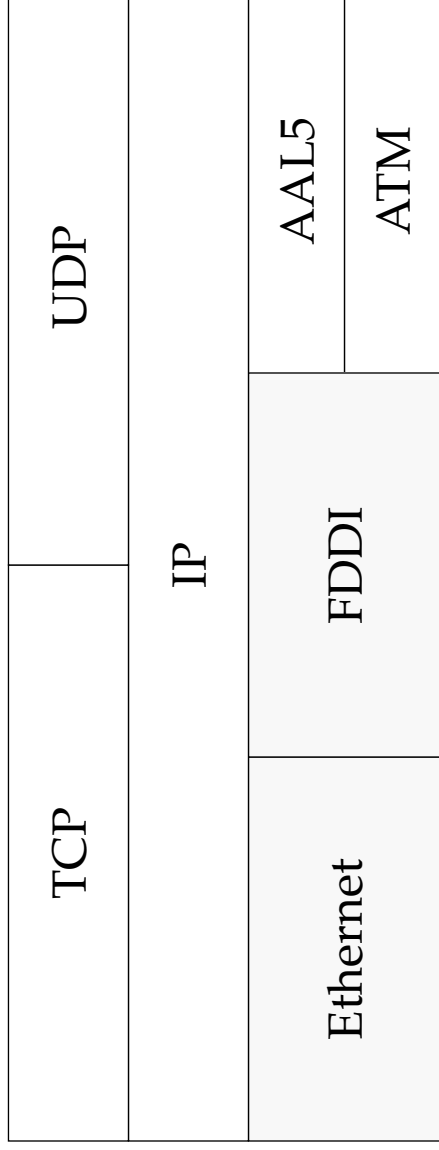
Environment: A Heterogeneous IP Internet



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. RSVP)

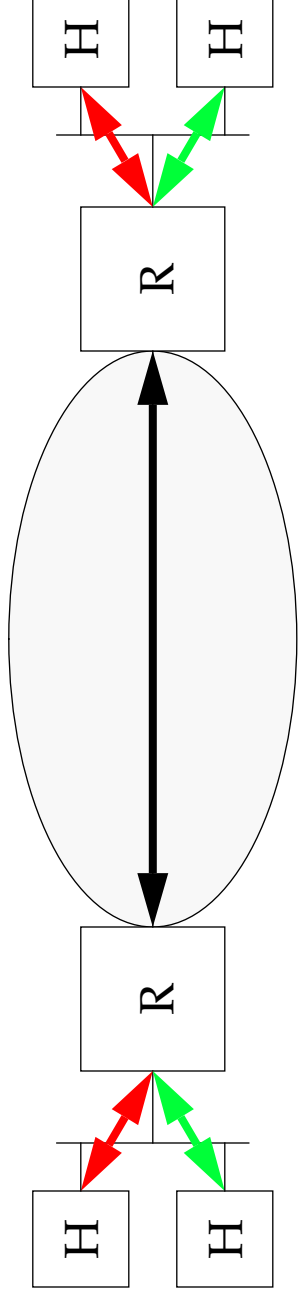
Multiplexing with QOS Considerations

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

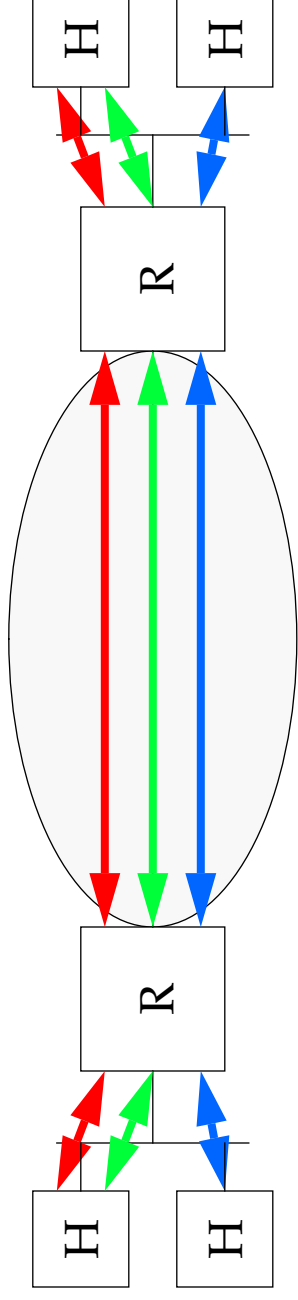
No protection among conversations sharing a router pair

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

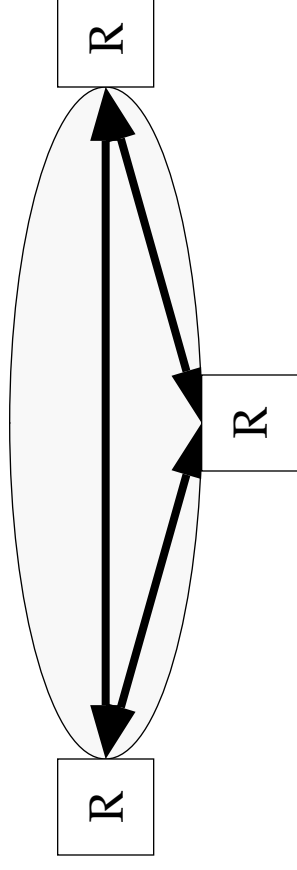
When to set up and tear down connections for datagrams?

Tradeoff

Long-lived virtual circuits: Tie up resources

Short-lived virtual circuits: Connection setup latency and processing

Permanent Virtual Circuits



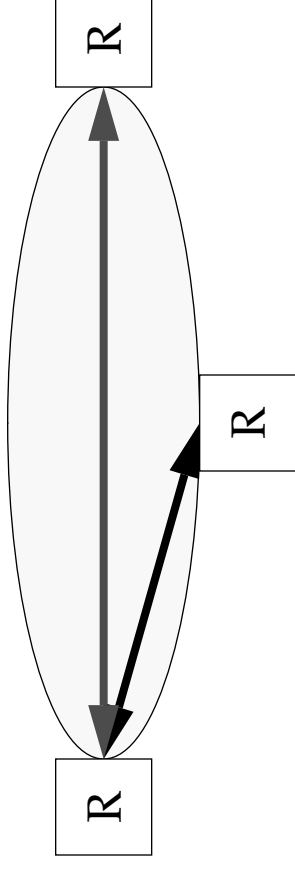
No connection setup latency

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

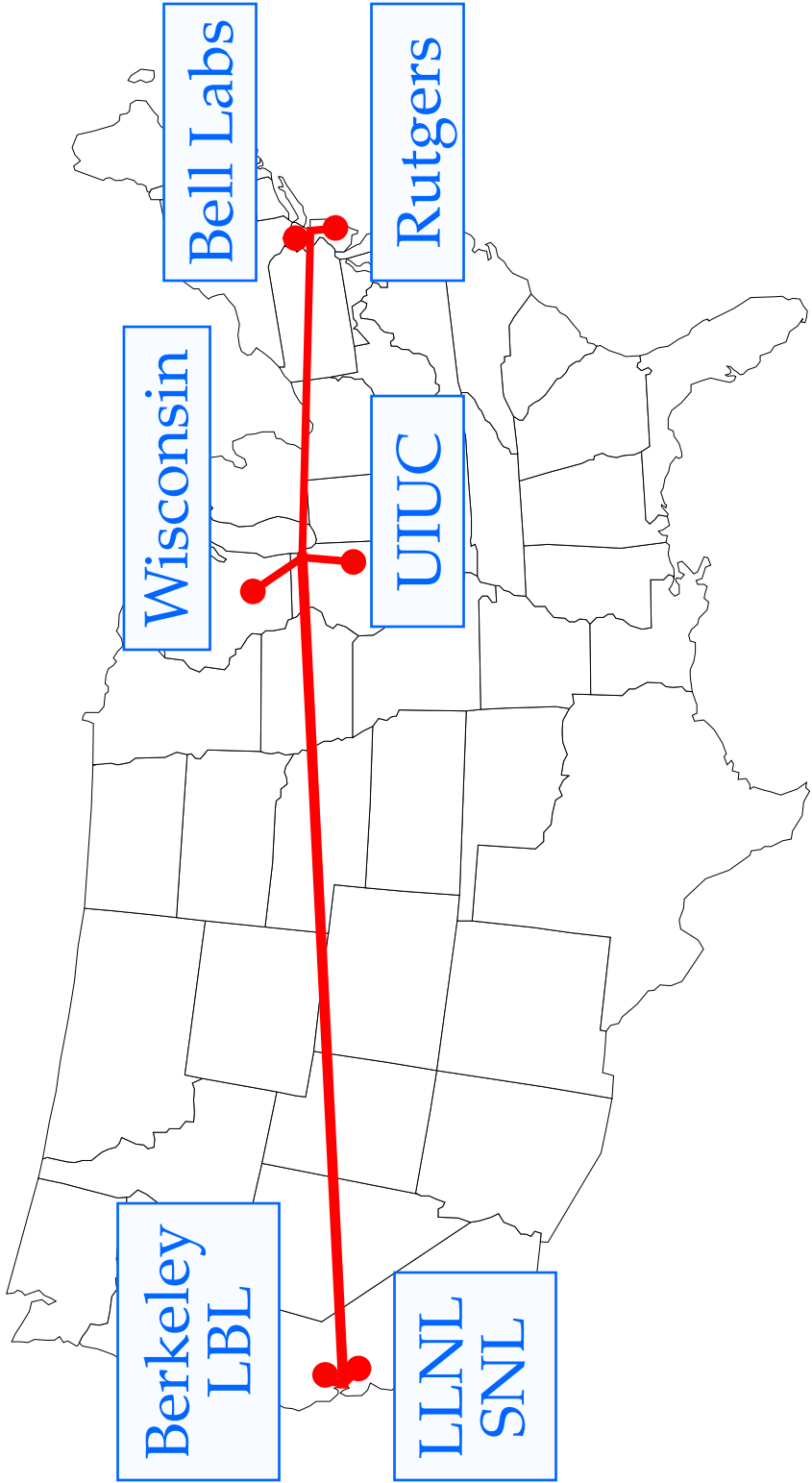
Connection setup latency incurred

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

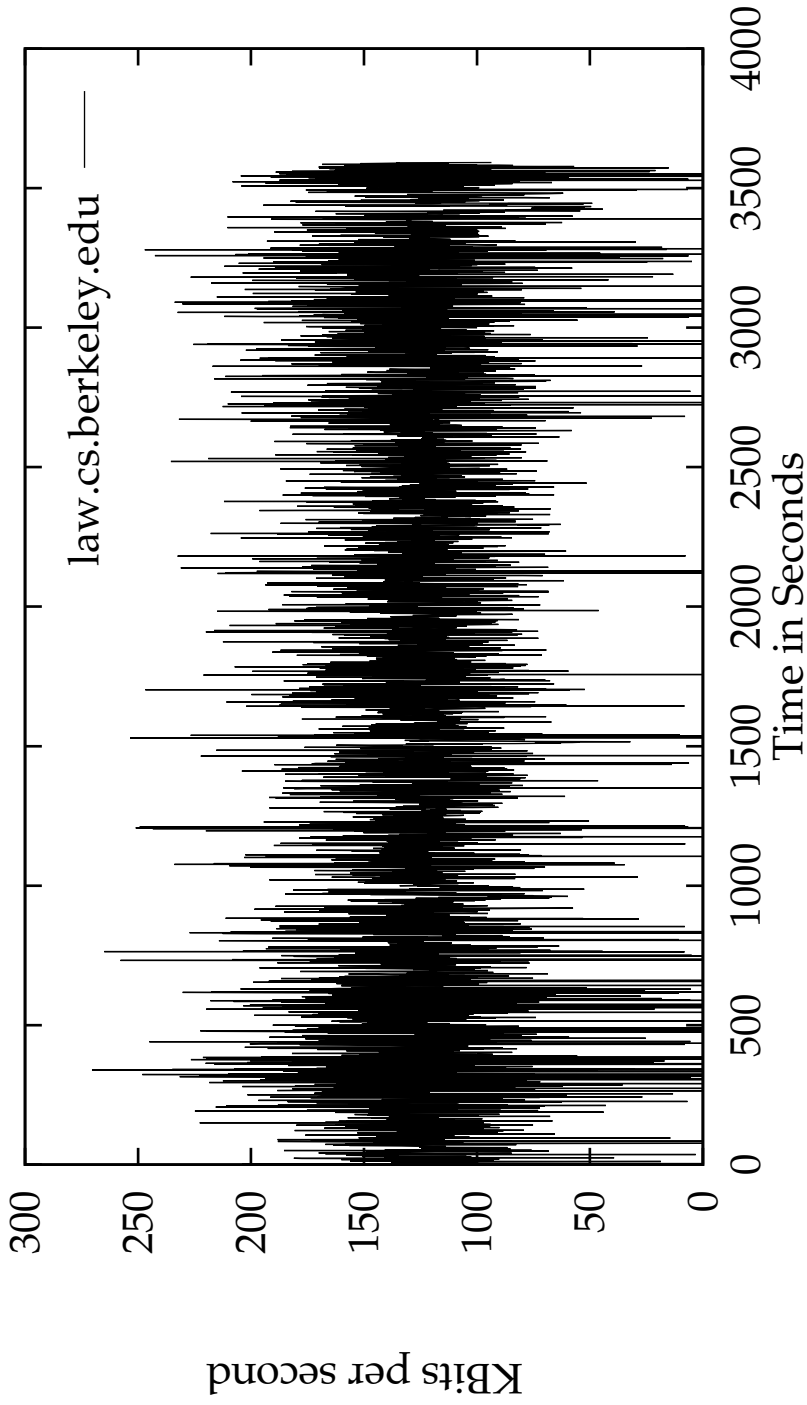
All UDP streams map to unique virtual circuits

XUNET IP over ATM service enhanced to use SVCs

Virtual circuits created on demand

Fixed idle timeout

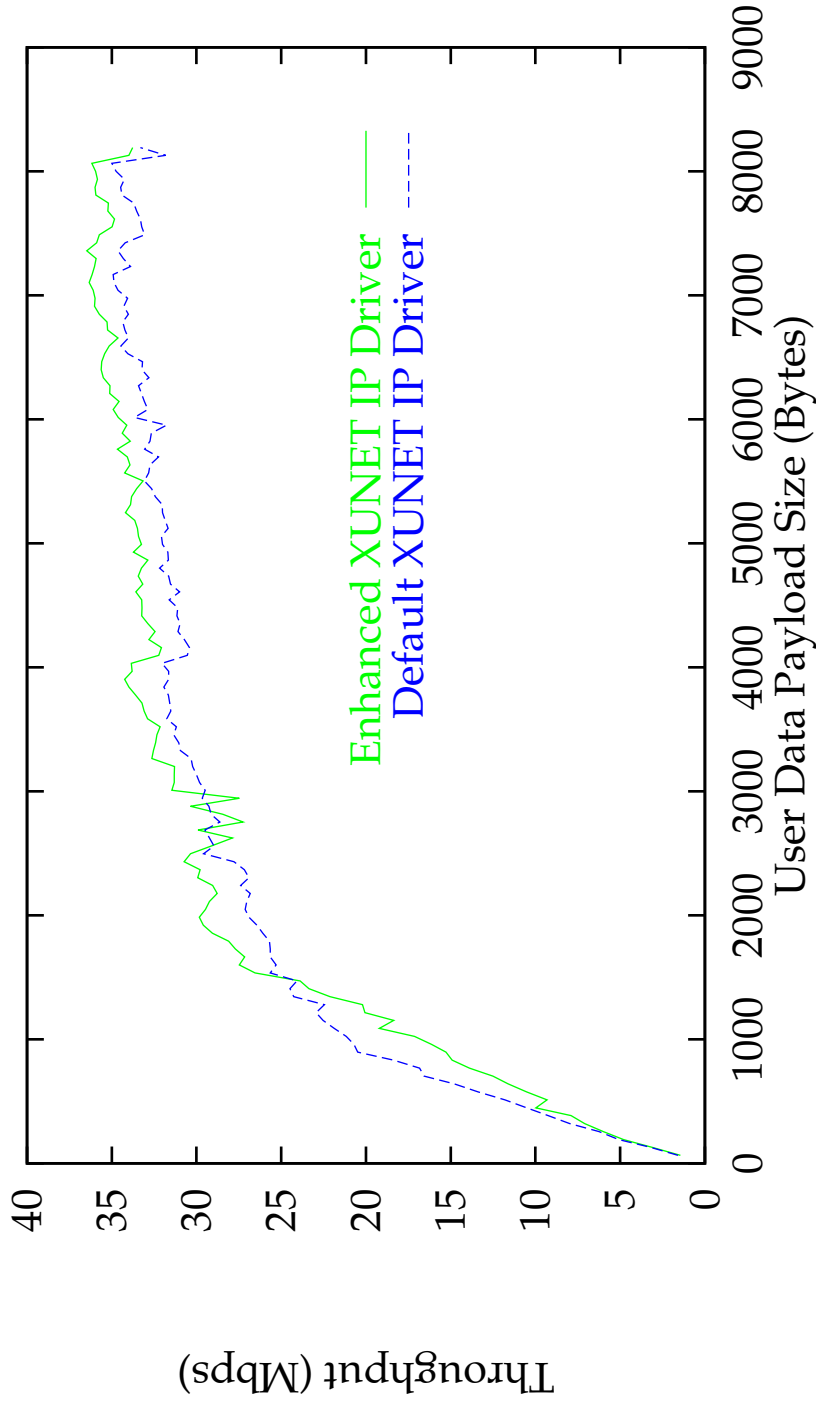
Video Bitrate (nv 128 Kbps)



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