Simulation Results of TCP Performance over ATM with Flow Control and Selective Cell-drop

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Background

- ATM is the emerging standard for LAN/MAN/WAN
  - Voice, Video, Data services

- Legacy LAN
  - bottleneck is shared medium
  - uses MAC for congestion control

- ATM LAN
  - bottleneck at any switch output port
  - no congestion control for ABR service

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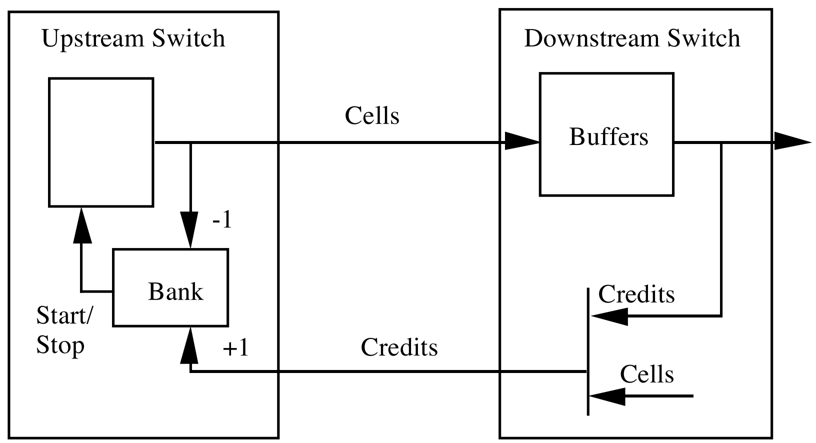
AN2 Switch Architecture

- 16 x 16 cross bar switch with internal fabric speed of 800 Mbps
- Each port can support one OC-12c connection or four OC-3c connections
- Input buffered with per VC buffer management and bypass mechanism to prevent HOL blocking

AN2 per VC per Hop Credit-based Flow Control

For Each VC:



Need one link round trip of buffering per VC

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Simulator Based on MIT's NetSim with Added Components to Handle ATM Network

Simulates a network of components that sends messages to one another:

- Types of components:
  - User
  - TCP
  - Host (Ethernet adapter, AN2 host adapter, etc.)
  - Link (Point-to-point, OC-3c, etc.)
  - Switch (Router, AN2 Switch, Bridge,etc.)
- Components consists of a data structure and an action routine.
  Components schedule events for one another and cause things to happen.
- GUI interface to:
  - display network topology and simulation parameters
  - modify network and control the simulation

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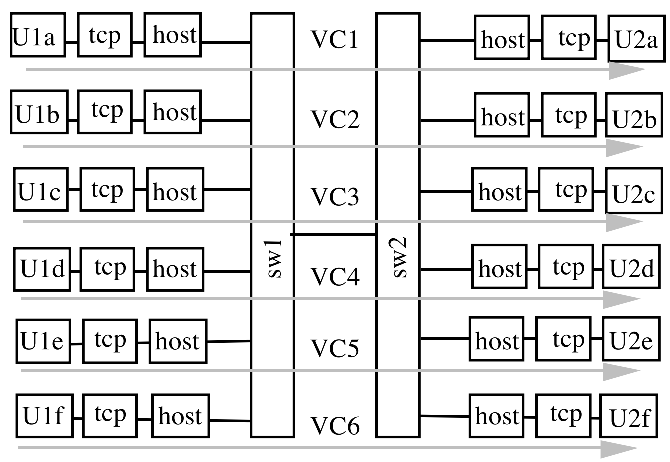
Simulated Network Configuration



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Simulation Parameters

Simulation Parameter	Value
TCP Window Size	64 Kbyte
TCP Segmentation Size	8 KByte
TCP Processing and OS Overhead Delay	300 μS
ATMhost Segmentation and Reassembly Delay	200 ηS
Switching Delay	4 μS
ATMswitch Per VC Input Queue Size (no Flow Control)	256 cells
Per VC Credit Grants (Flow Control)	5 cells
Link Serialization Delay at OC-3c Speed	2.7 μS
100 m propagation Delay	500 ηS

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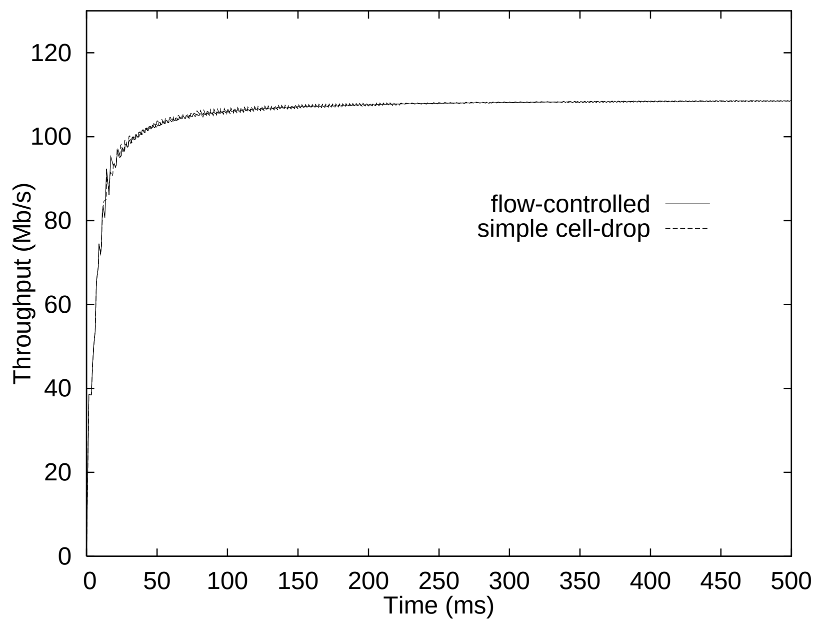
Baseline TCP Throughput with and without Flow Control



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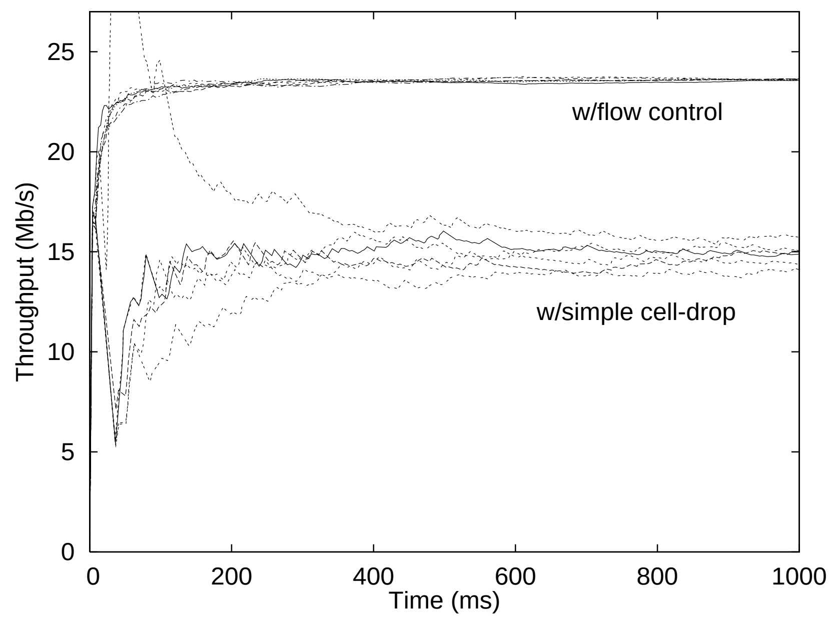
Comparison of TCP Performance for the Flow Controlled and the non Flow Controlled Simulations



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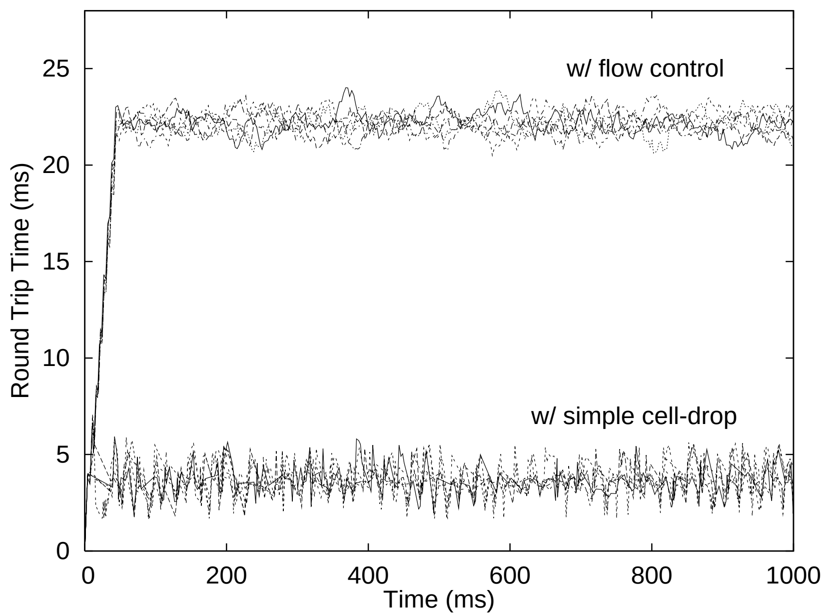
Comparison of the TCP RTT for the Flow Controlled and the non Flow Controlled Simulations



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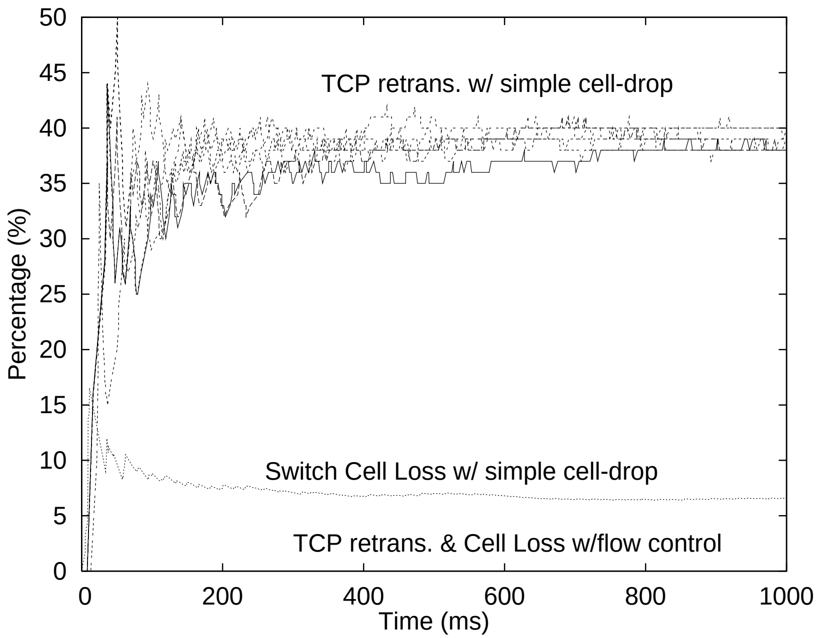
Comparison of the Cell-loss and TCP Retransimission rates for Flow Controlled and non Flow Controlled Simulations



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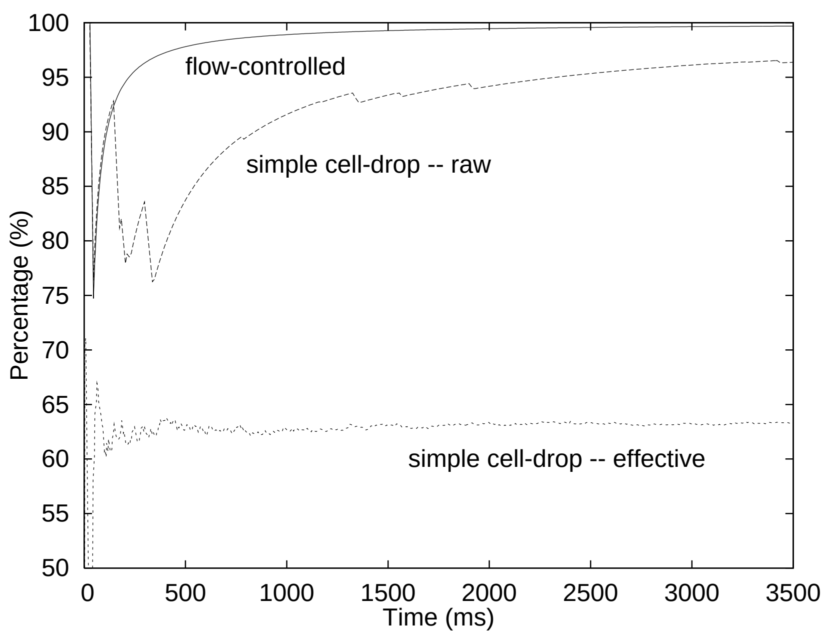
Comparison of Effective Link Utilization for the Flow Controlled and the non Flow Controlled Simulations



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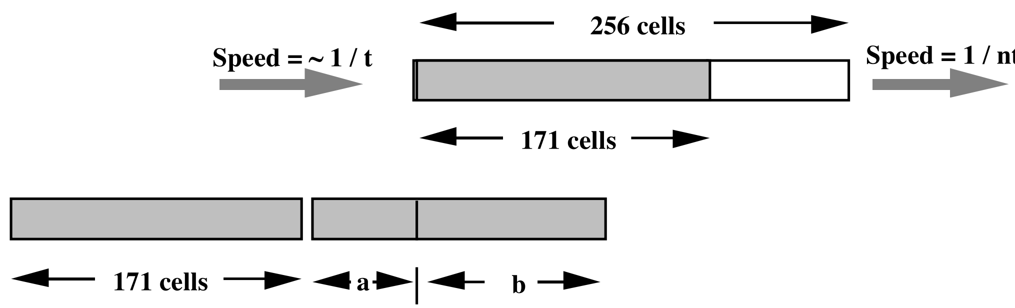
Per VC queue status of a congested input port



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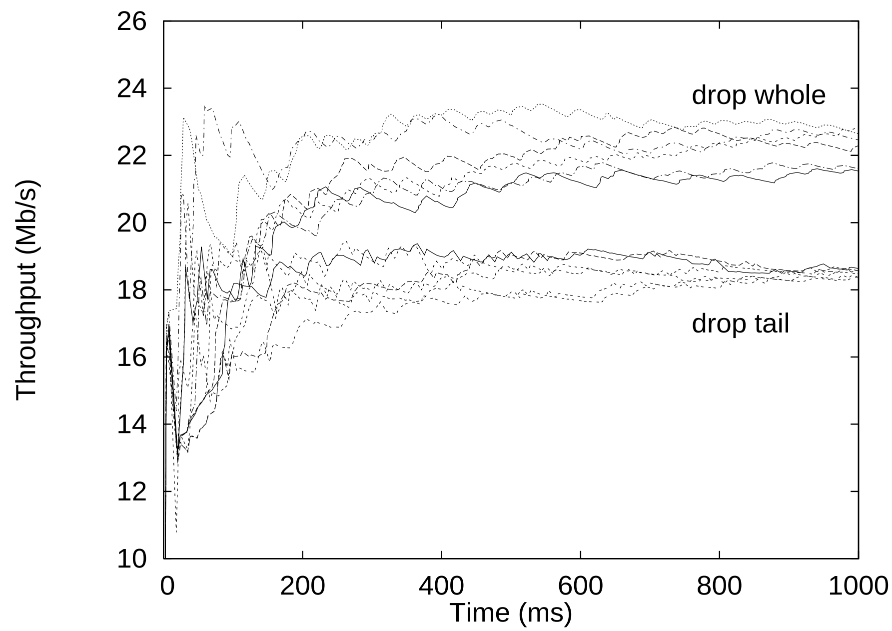
TCP Throughput Comparison of the Selective Cell-drop Schemes



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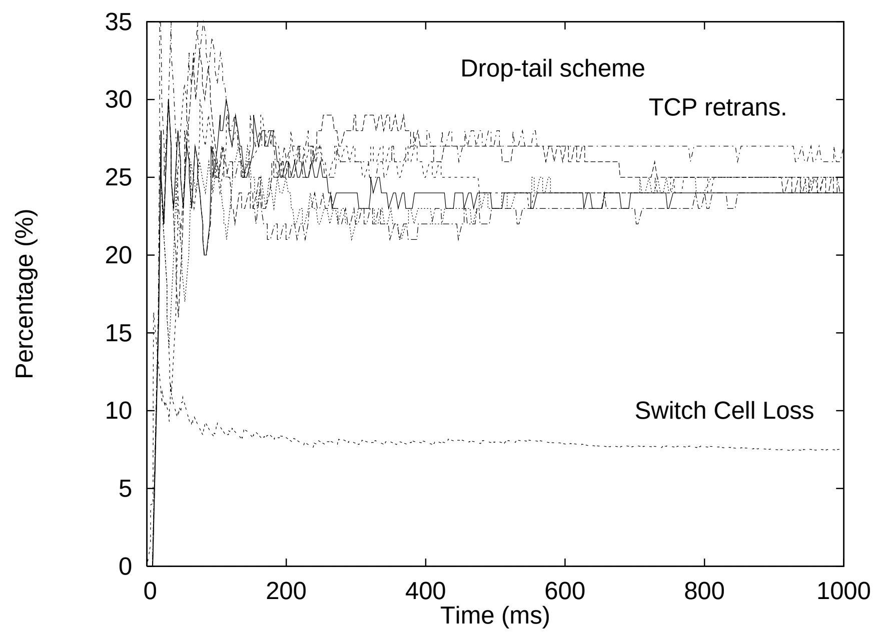
Cell-loss and TCP Retransmission Rates for the Drop-tail scheme



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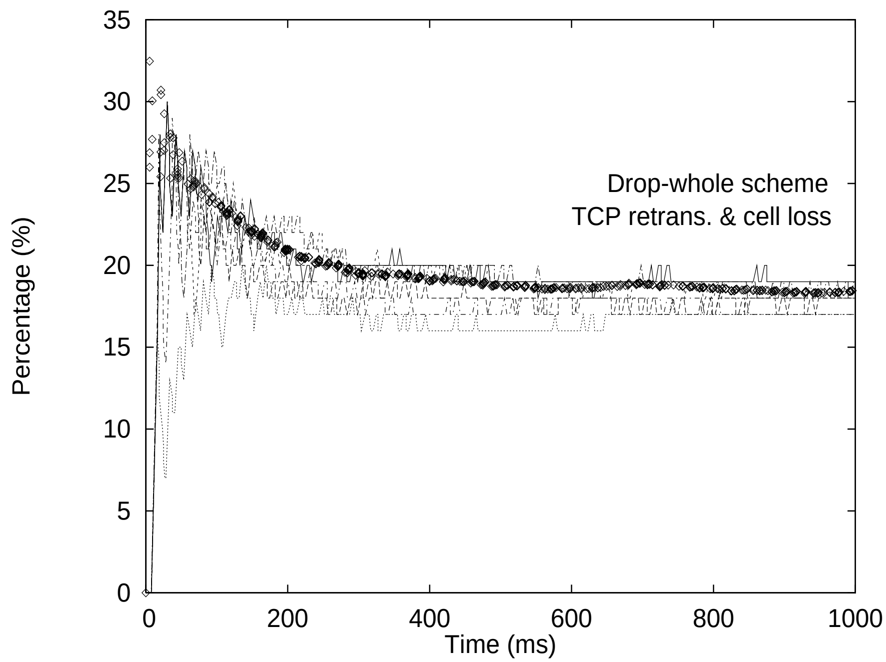
Cell-loss and TCP Retransmission Rates for the Drop-whole scheme



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Summary

- DEC's flow control provided optimum TCP performance:
  - Full link utilization, 23.4 Mbps, fair, 5 cells per VC

- The selective cell "Drop-whole" scheme demonstrated a 4% throughput degradation:
  - 18%cell loss, 18% TCP retransmission, 22.5 Mbps, and 256 cells per VC

- The selective cell "Drop-tail" scheme demonstarted a 21% throughput degradation:
  - 7.5% cell-loss, 25% TCP retransmission, 18Mbps, and 256 cells per VC

- The no-flow simulation demonstrated a 36%throughput degradation:
  - 6.5% cell-drop, 40% TCP retransmission, 15 Mbps, and 256 cells/VC

Conclusion

- A mechanism must be present in ATM to handle congestion: per VC ECN, per VC Flow Control, or Selective Cell "Drop-whole"

- A cost performance study between the DEC Flow Control and the Selective Cell "Drop-whole" can be interesting

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Future Work

- Include other ATM level flow control proposals:
  - FECN, BECN, FECN/GFC, BECN/GFC
  - Applicability to WAN
- Implement other protocols:
  - NFS, IPX, XTP, etc.
- Implement other applications:
  - interactive, realtime, imaging, etc.
- Implement other services:
  - CBR, VBR