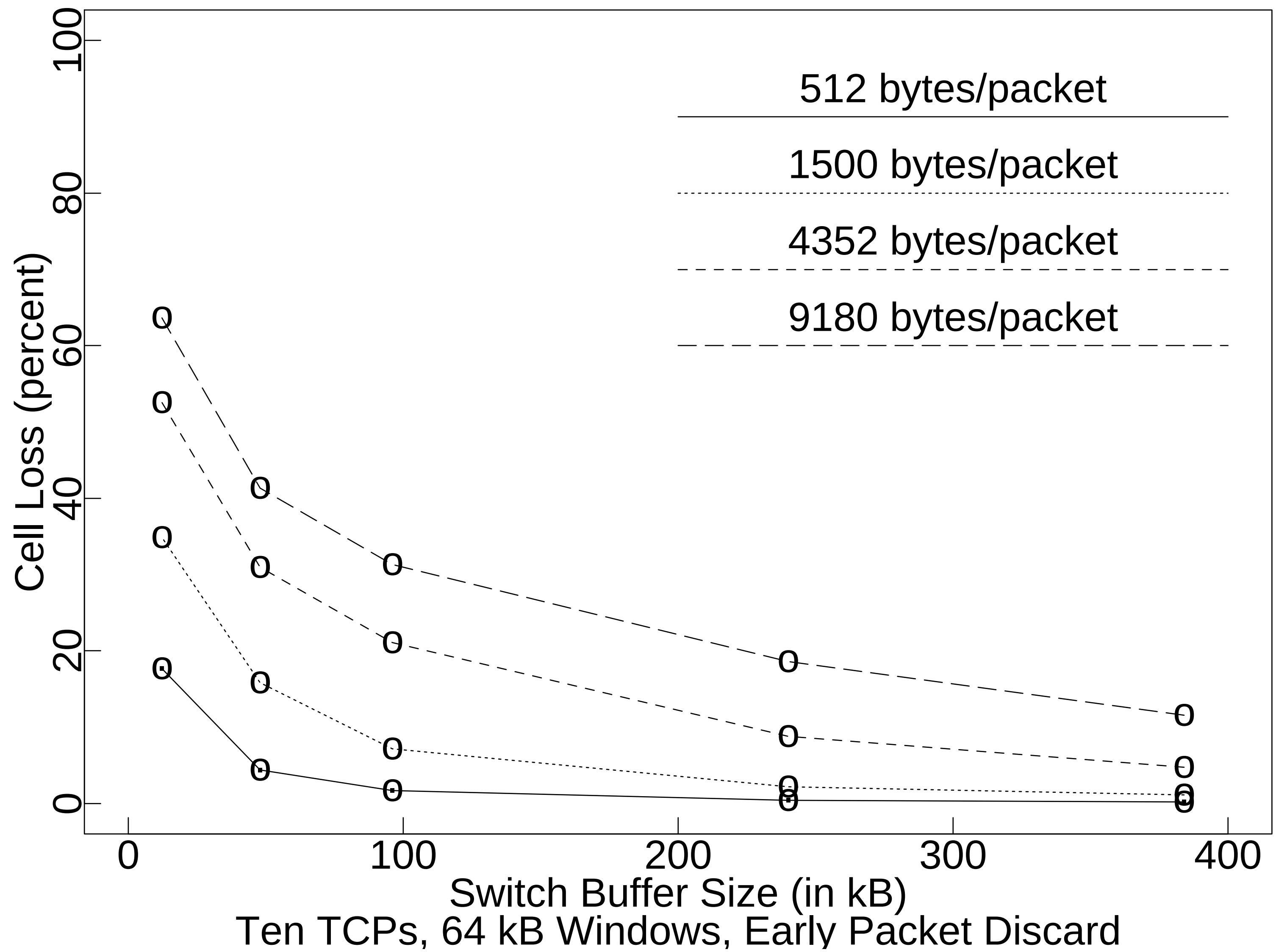
EPD: Cell Loss Rate by Buffer Size



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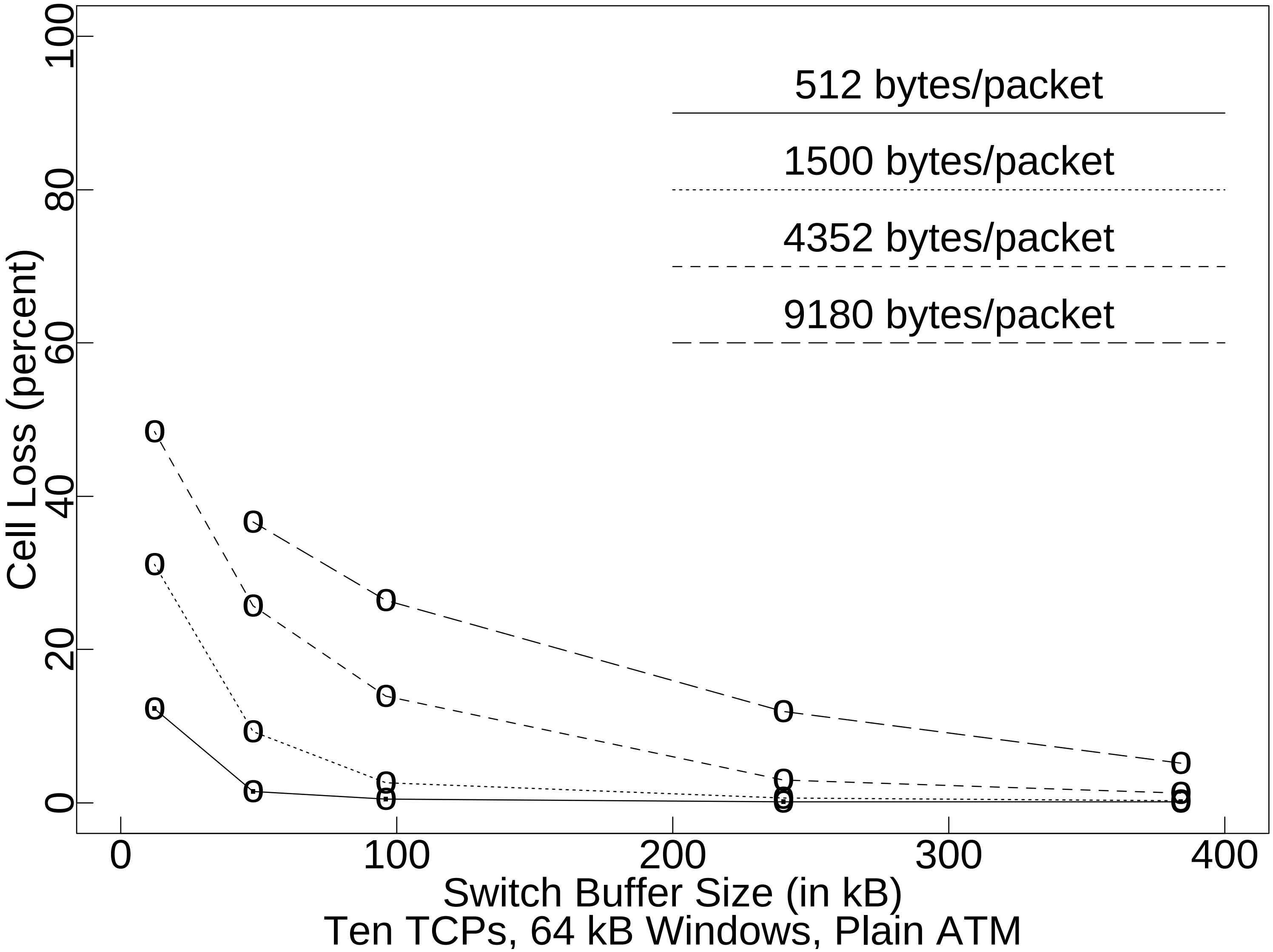
Plain ATM: Cell Loss Rate by Buffer Size



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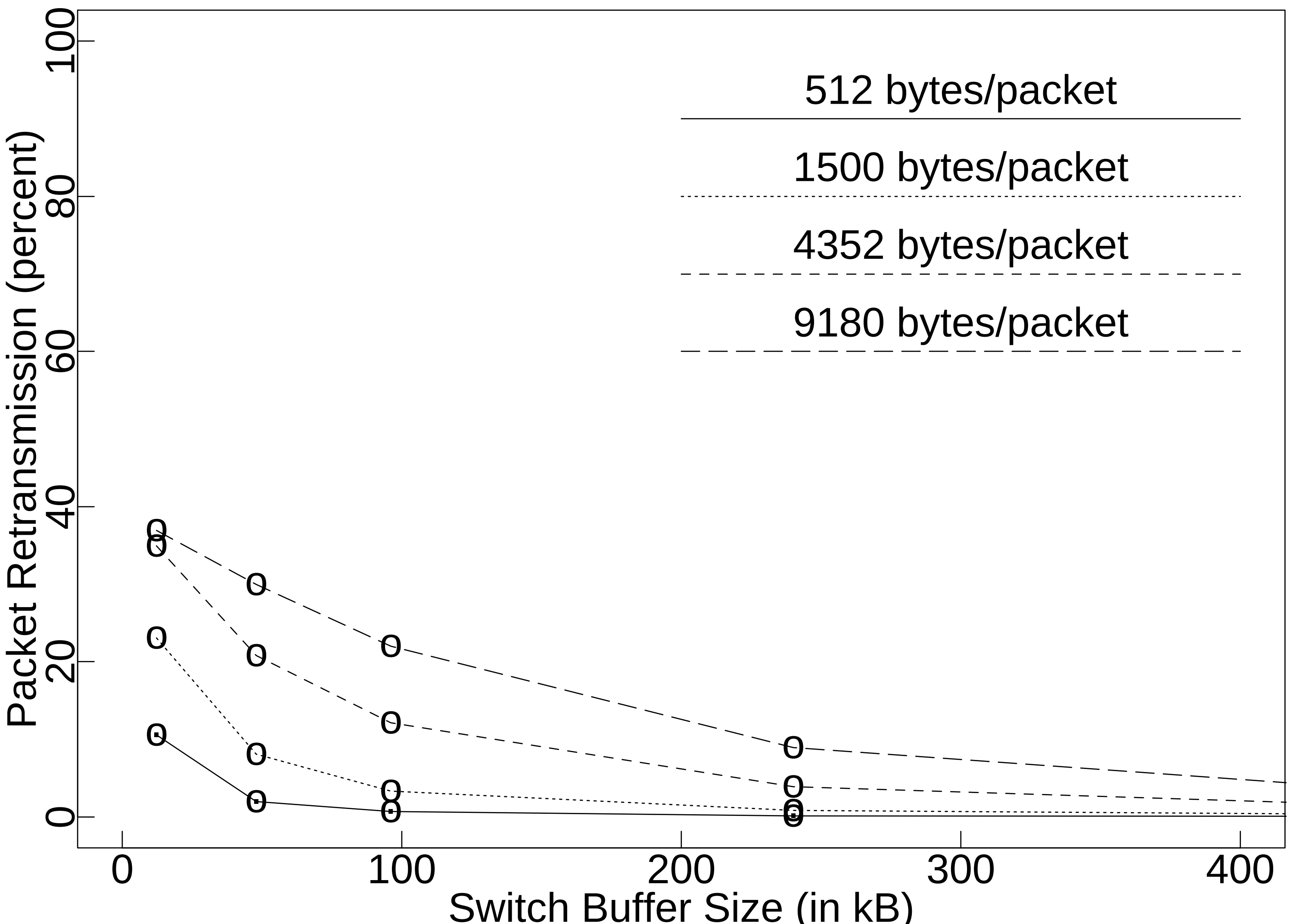
Packet TCP: Percent Pkt Retransmission by Buffer Size



Ten TCPs, 64 kB Windows, Packet TCP

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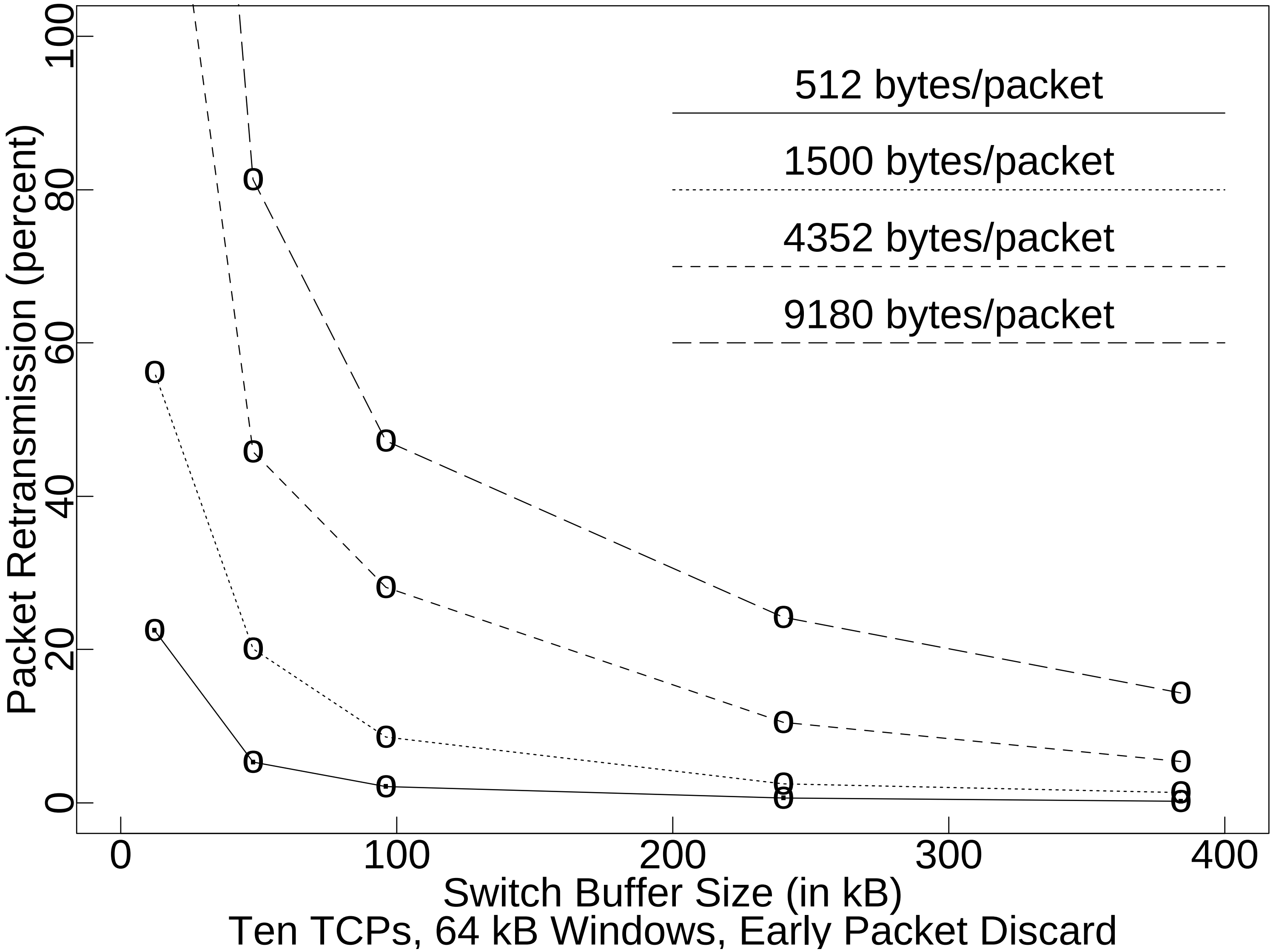
EPD: Percent Pkt Retransmission by Buffer Size



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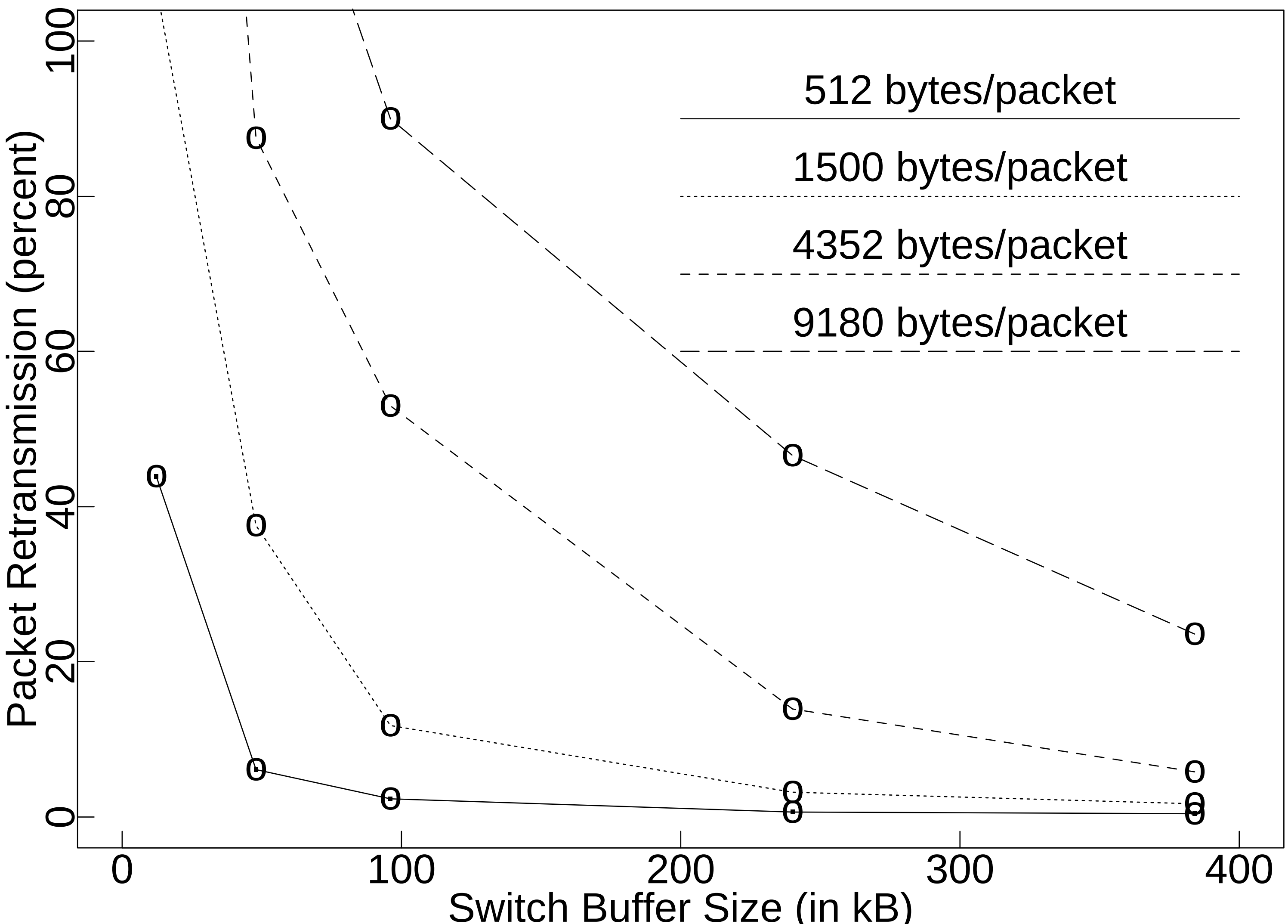
Plain ATM: Percent Pkt Retransmission by Buffer Size



Ten TCPs, 64 kB Windows, Plain ATM

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Future Work

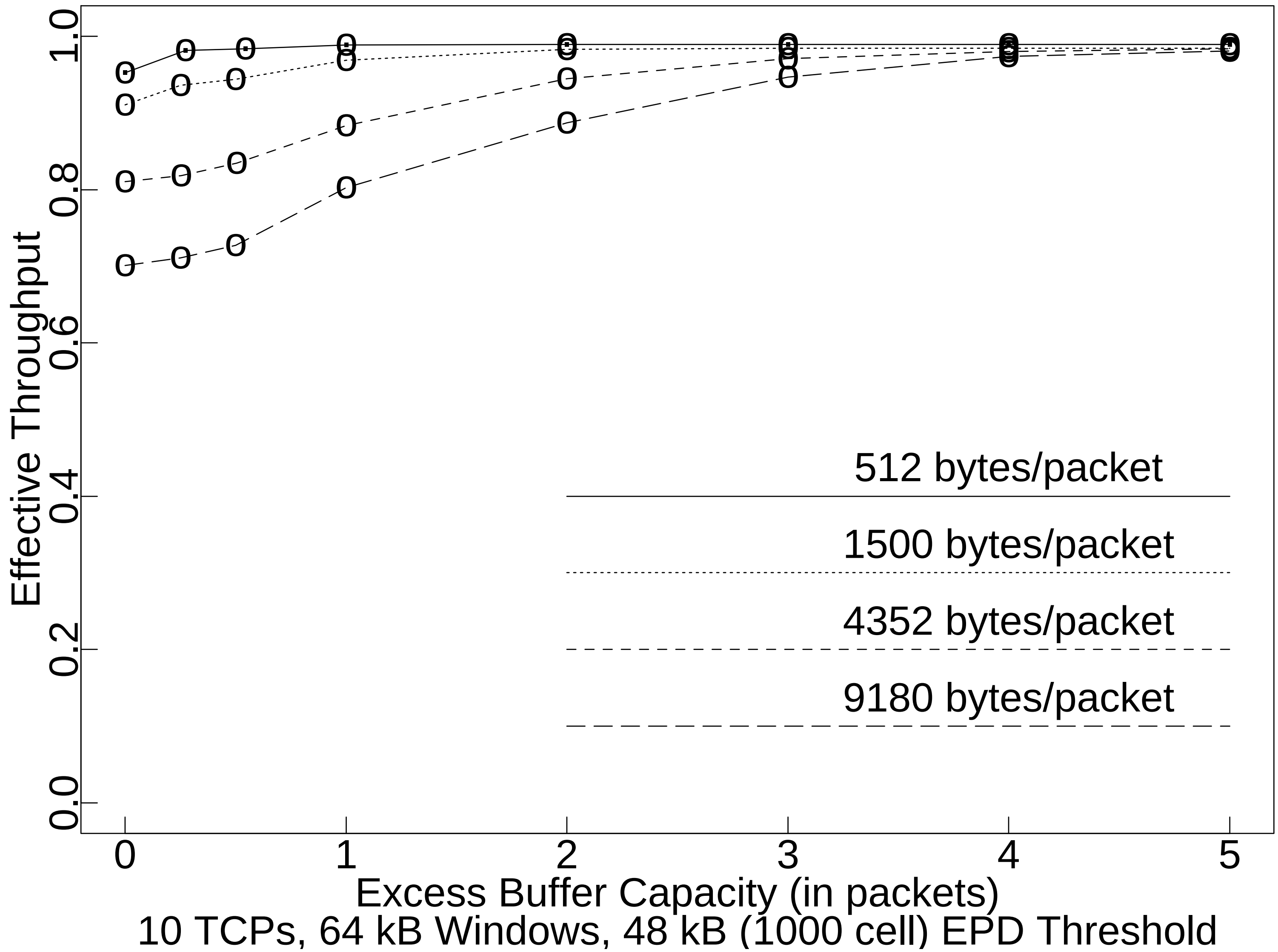
- Investigate PPD/EPD with
  - different traffic models
  - different congestion control schemes
  - richer topology - more switches

- Modifications to TCP
  - Explicit notification
  - Dynamic packet size, window size

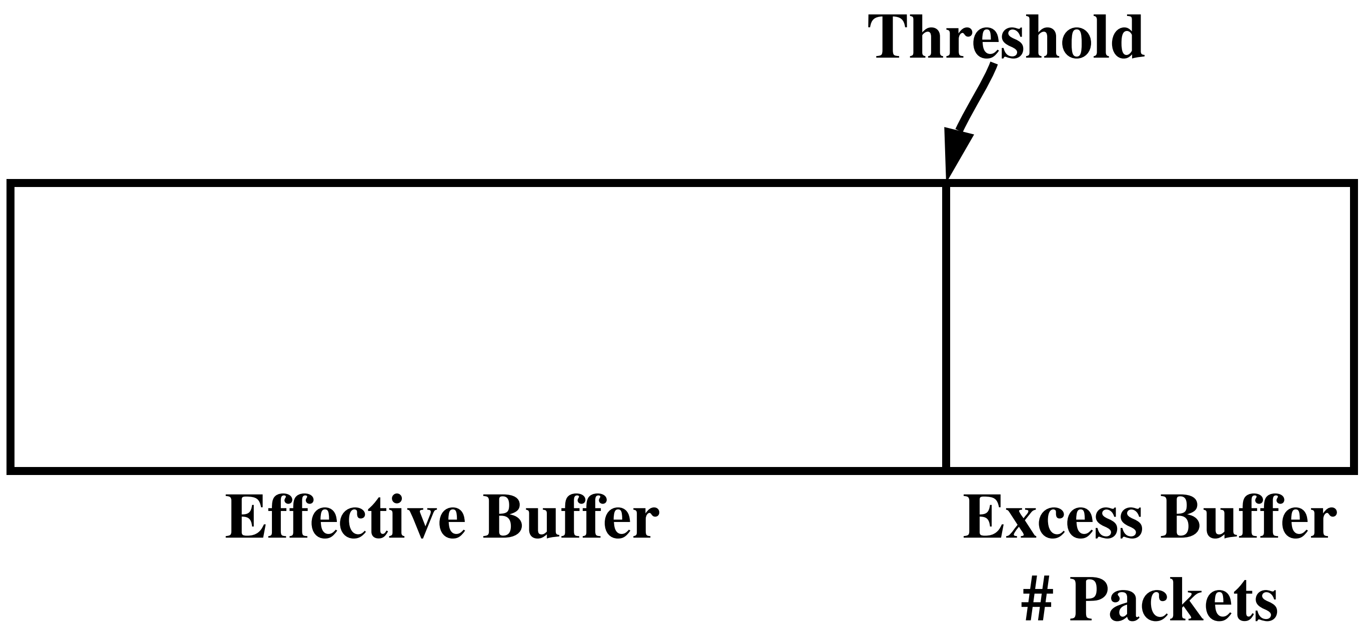
More about Early Packet Discard

- Improves throughput
- Does not address fairness,
  controlling misbehaving users, low delay
- Can be used with other traffic control mechanisms
- Tolerates occasional buffer overflow
- May not have low retransmission rate
- Performance for non-TCP protocols -
  similar to packet switch
- Bias against small packets
- Doesn’t require cooperation among switches, hosts

EPD Threshold: 1000 Cells



Setting the EPD Threshold



Setting the EPD Threshold

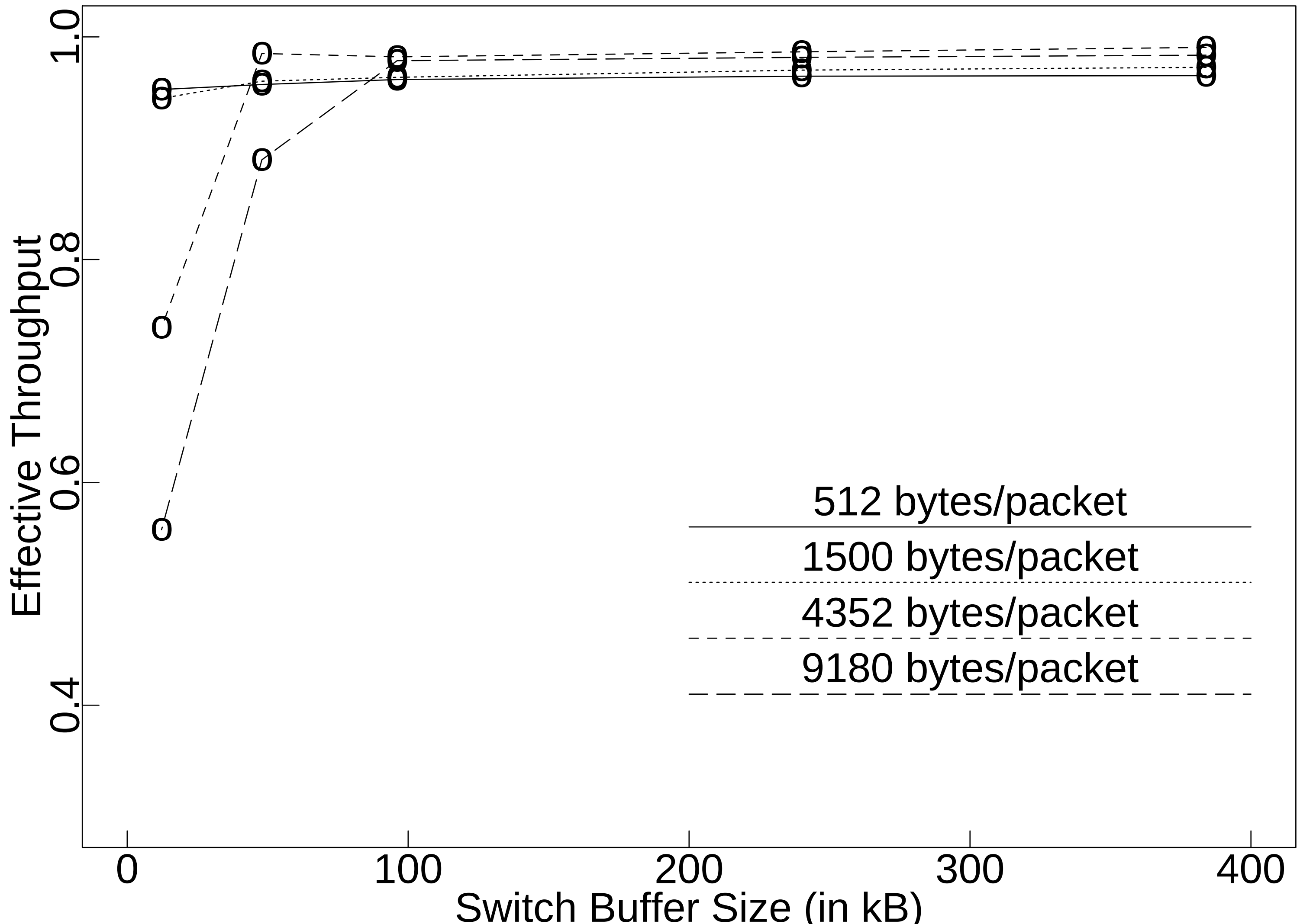
- Efficient use of buffer vs. dropping cells

- Size of excess buffer depends on
  - Distribution of packet sizes
  - Traffic
  - Duration of congestion epoch
  - Interaction with congestion control mechanisms

Early Packet Discard

- Drop complete packets
- High effective throughput
- Implementation
    - AAL5
    - Signal on a per VC basis
    - Threshold

Early Packet Discard: Effective Throughput by Buffer Size

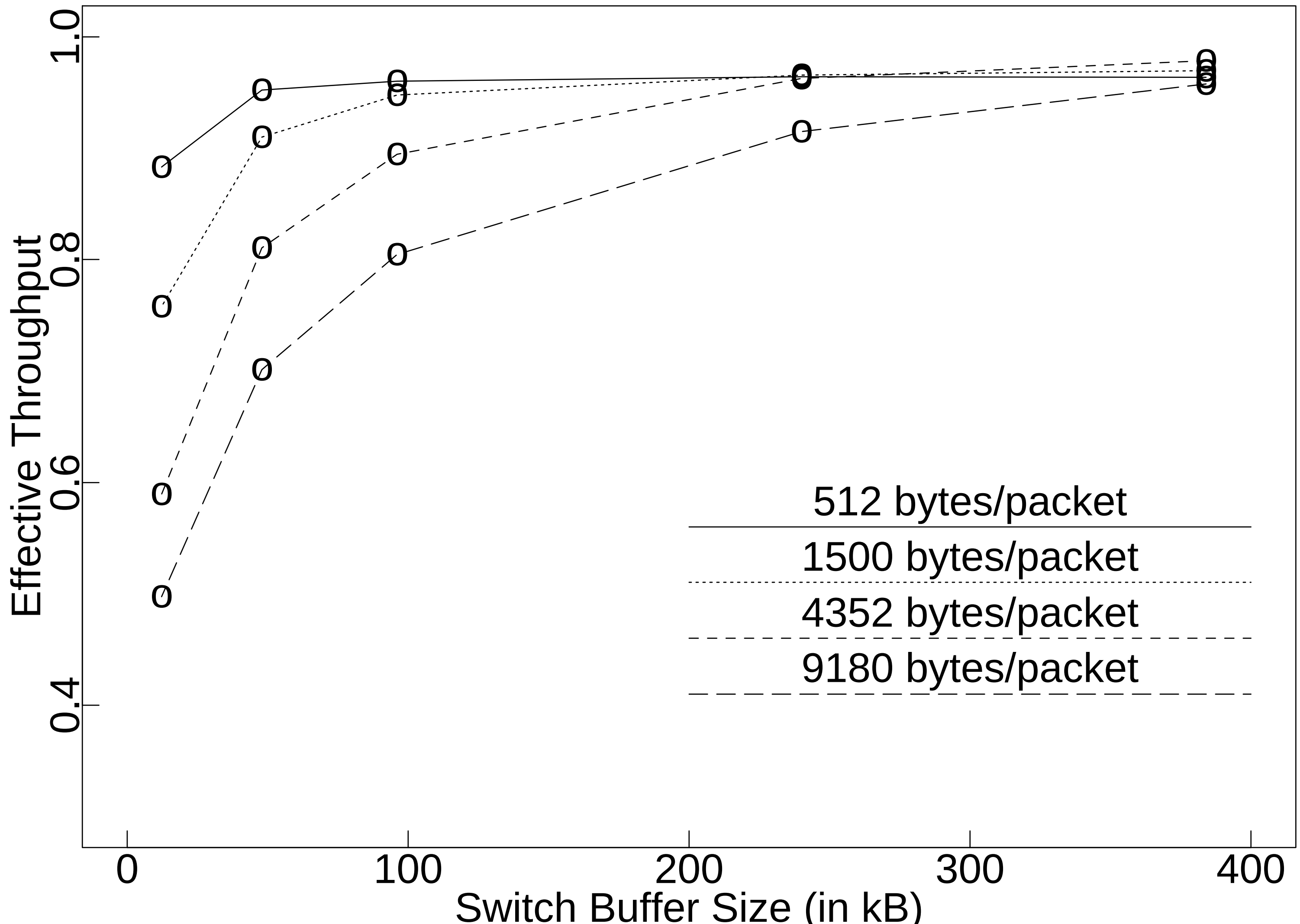


Ten TCPs, 64 kB Windows, ATM, Early Packet Discard

Partial Packet Discard

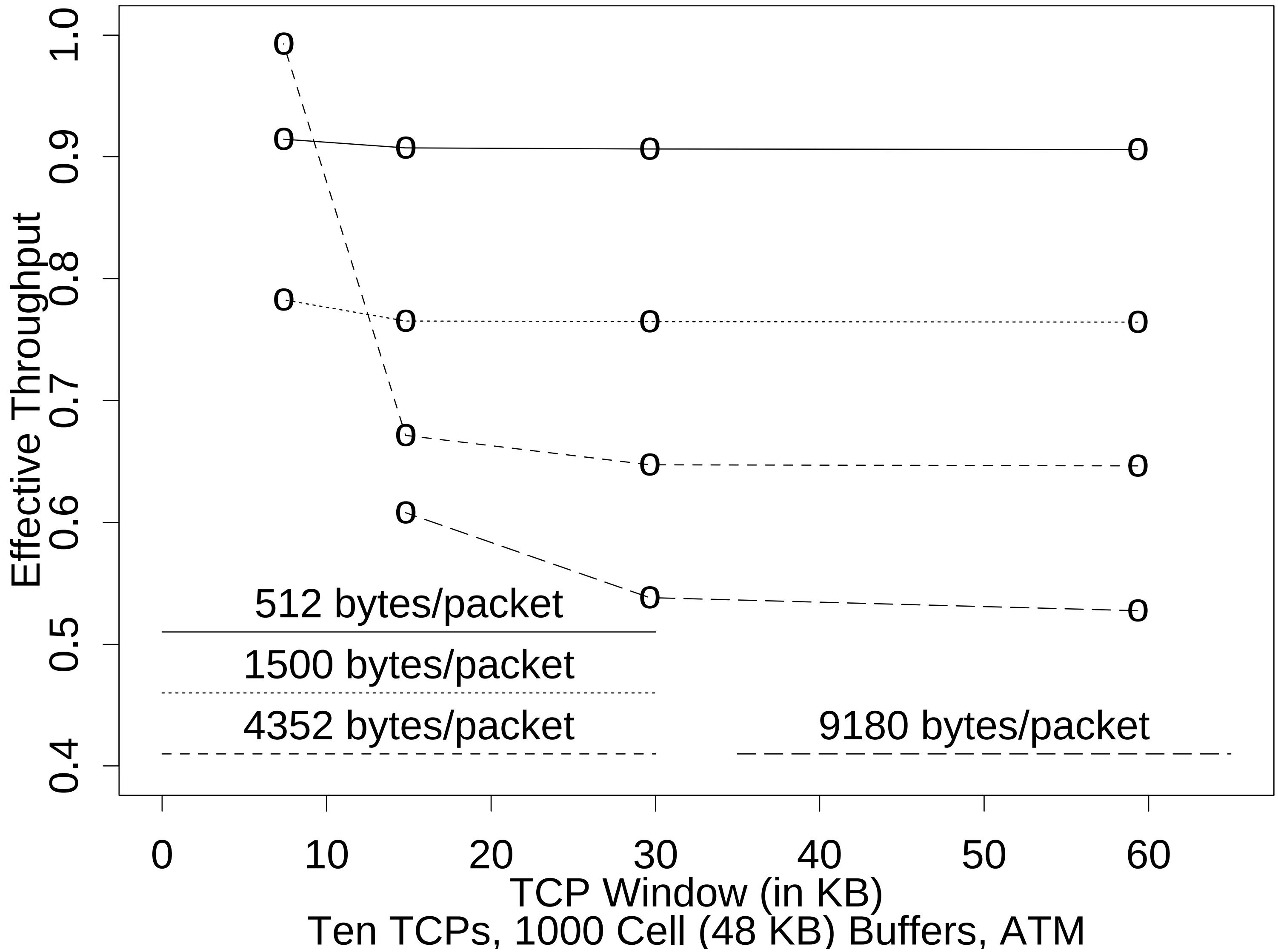
- Widely suggested
- Improved performance
- Limited improvement
  Depends on position of first discarded cell
- Implementation
  Table in the switch - VC

Partial Packet Discard: Throughput by Buffer Size



Ten TCPs, 64 kB Windows, ATM, Partial Packet Discard

TCP over ATM: Effective Throughput by Window Size



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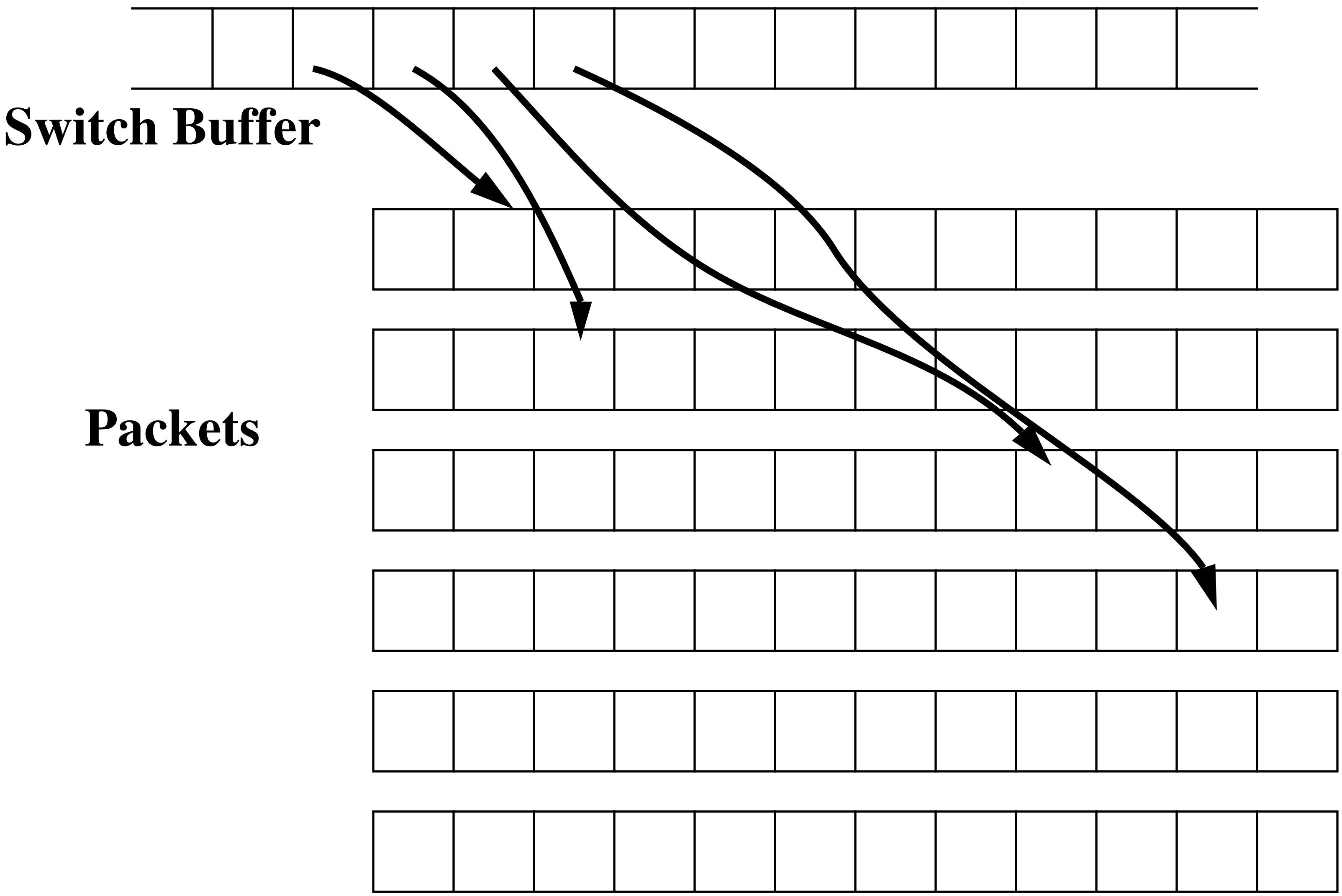
Effects of Various Factors

- Switch buffer size
  - Large buffers can't be only solution - delay
- TCP packet size
  - Dynamic parameters
- Increasing congestion

Fragmentation !

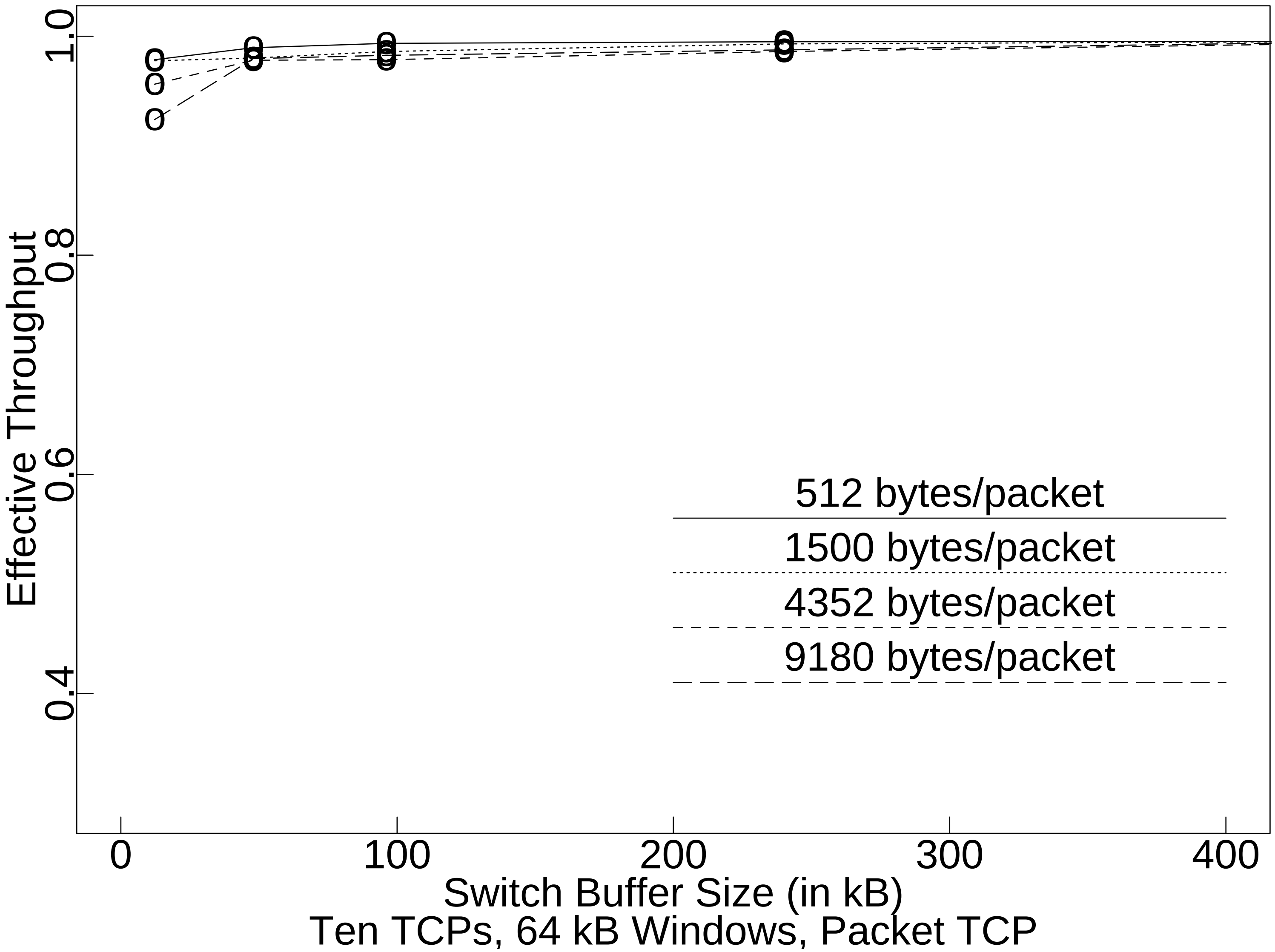


Reasons for Poor Results

- **Fragmentation-**
  Cells from "dead" packets congest the link

- **Link idle time - global synchronization - minor effect**

Packet TCP: Effective Throughput by Buffer Size



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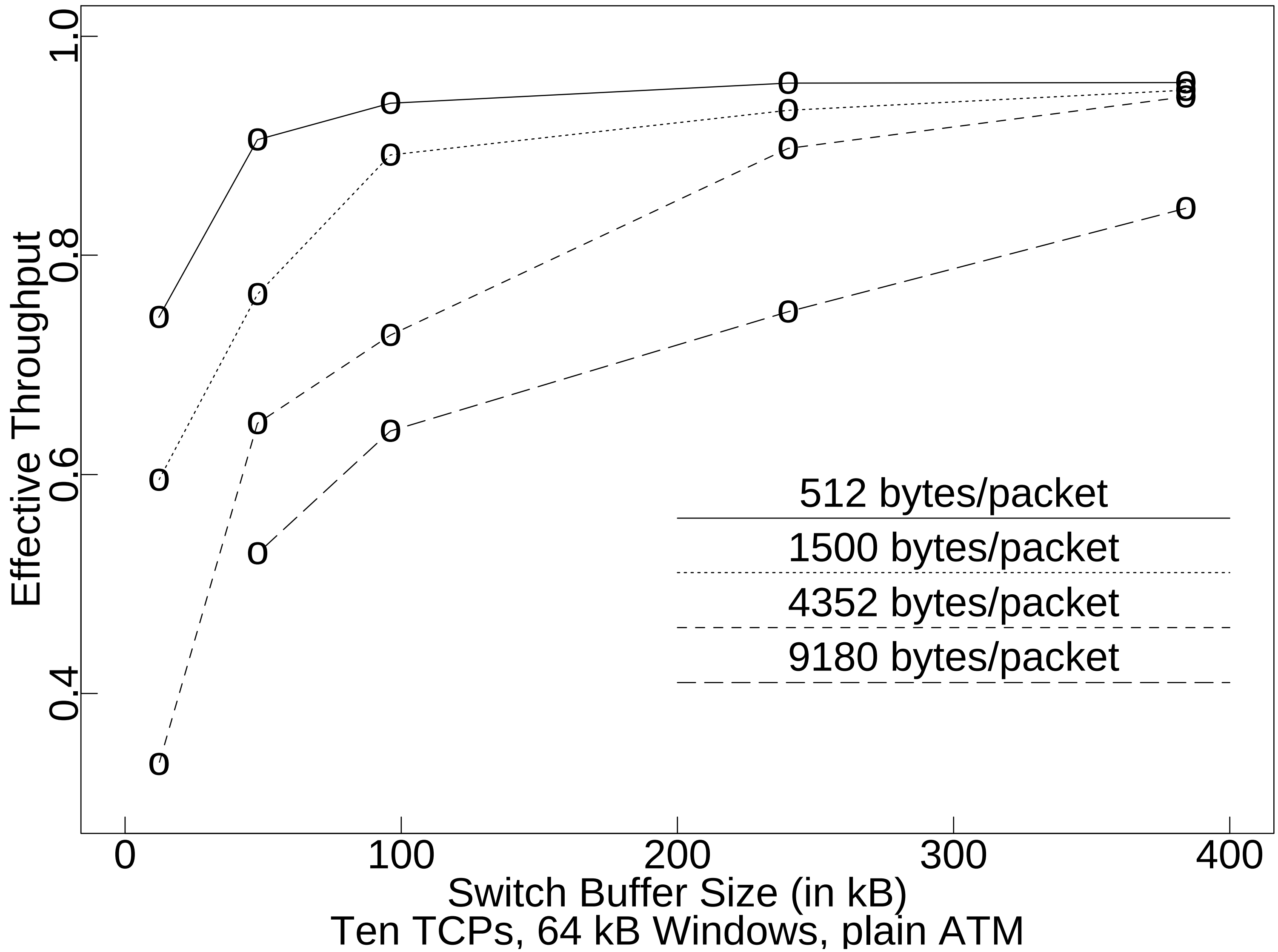
TCP over ATM: Effective Throughput by Buffer Size



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Variable Parameters

- Switch buffer size per port
  256 1000 2000 5000 8000 cells
- TCP packet size
  512 1500 4352 9180 bytes
- TCP window size
  8k 16k 32k 64k

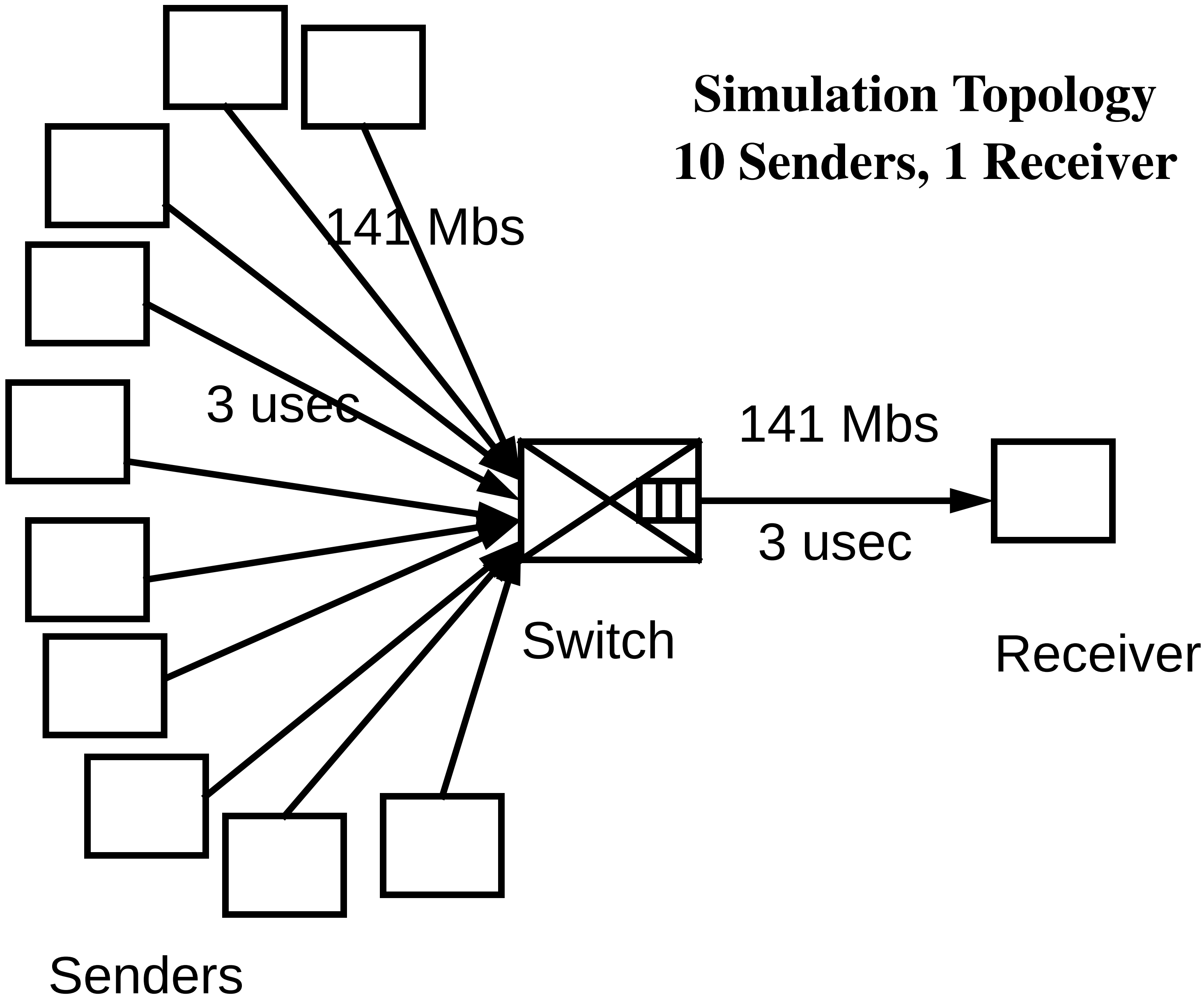
Performance Measure

- Percent effective throughput

Simulations

- Packet simulator - Sally Floyd, REAL simulator
- ATM simulator - version of Lixia Zhang's
- 16 ports
- FIFO queueing
- TCP BSD 4.3 Tahoe - slow start, fast retransmission
- Traffic model - infinite data stream
- 250MBytes data transferred
- TCP per VC
- 10 TCPs
- ATM switch output buffered, Batcher Banyan

Simulation Topology
10 Senders, 1 Receiver



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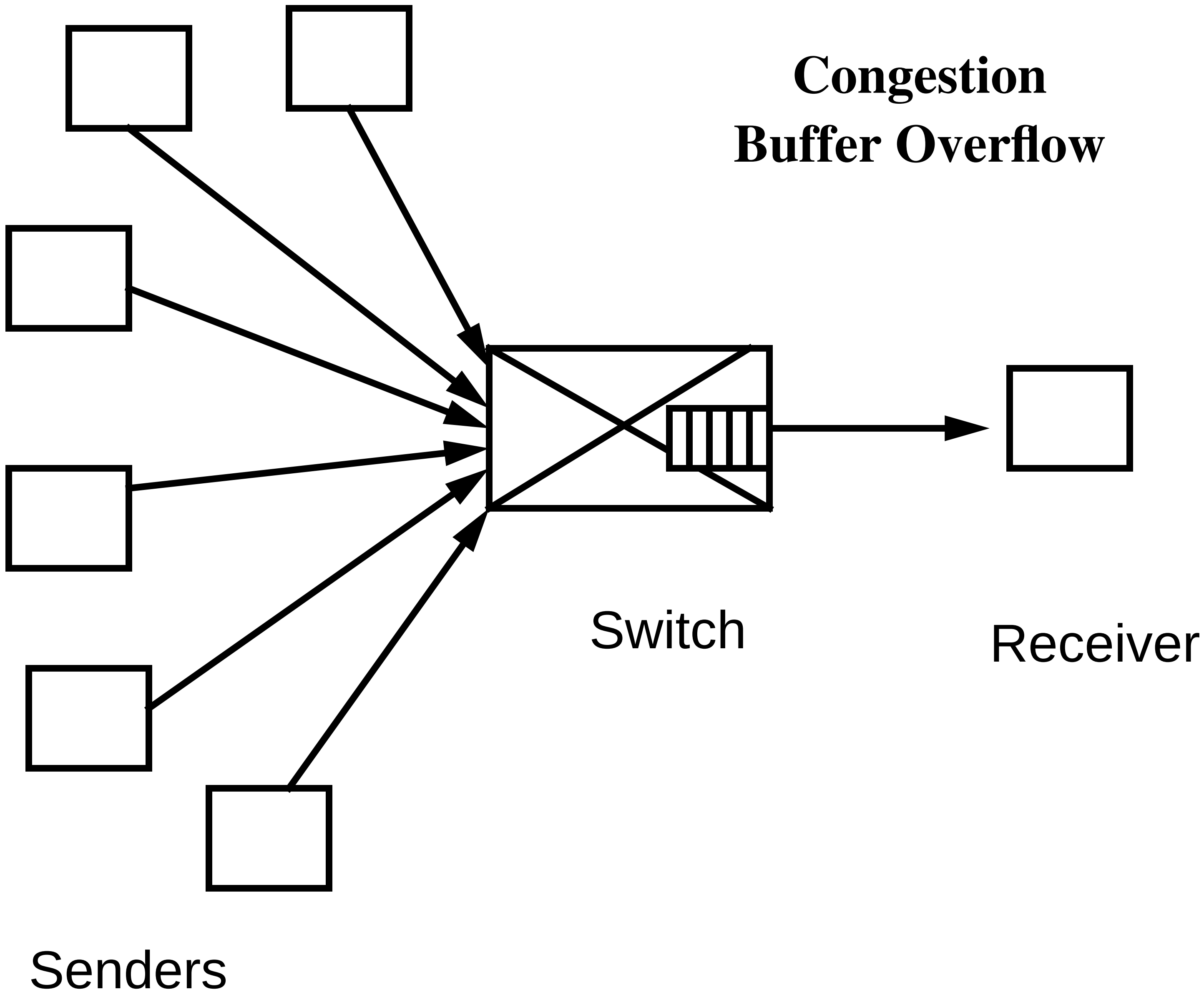
Will TCP Congestion Control Work for ATM LAN?- method

- Simulation studies
  - Analysis - dynamics
- Compare packet TCP with TCP over plain ATM

Congestion
Buffer Overflow



What’s the Problem?

- ATM today -
  - Support existing base
  - TCP/IP
  - Heterogeneous networks
- At the minimum TCP has to run well
  - Best efforts traffic - not real-time
  - Assume QoS with classes
- Congestion --> network collapse

Outline

- How it started - Is TCP's congestion control adequate for ATM
- The problem
- Performance of TCP over ATM
  - Without additional mechanisms
  - Compare with packet TCP
  - Partial packet discard
  - Early packet discard

The Dynamics of TCP Traffic Over ATM Networks

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