Making Half-Duplex Repeaters Attractive for Gigabit CSMA/CD

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CSMA/CD and a Half-Duplex Repeater are going into the standard

- CSMA/CD on 200m topology is a goal
- Carrier extension and frame bursting are being added to Clause 4
- Clause 41 defines a half-duplex repeater
- There is no consensus on what to include about buffered distributors
- There is little interest in building repeaters

What's Wrong with CSMA/CD?

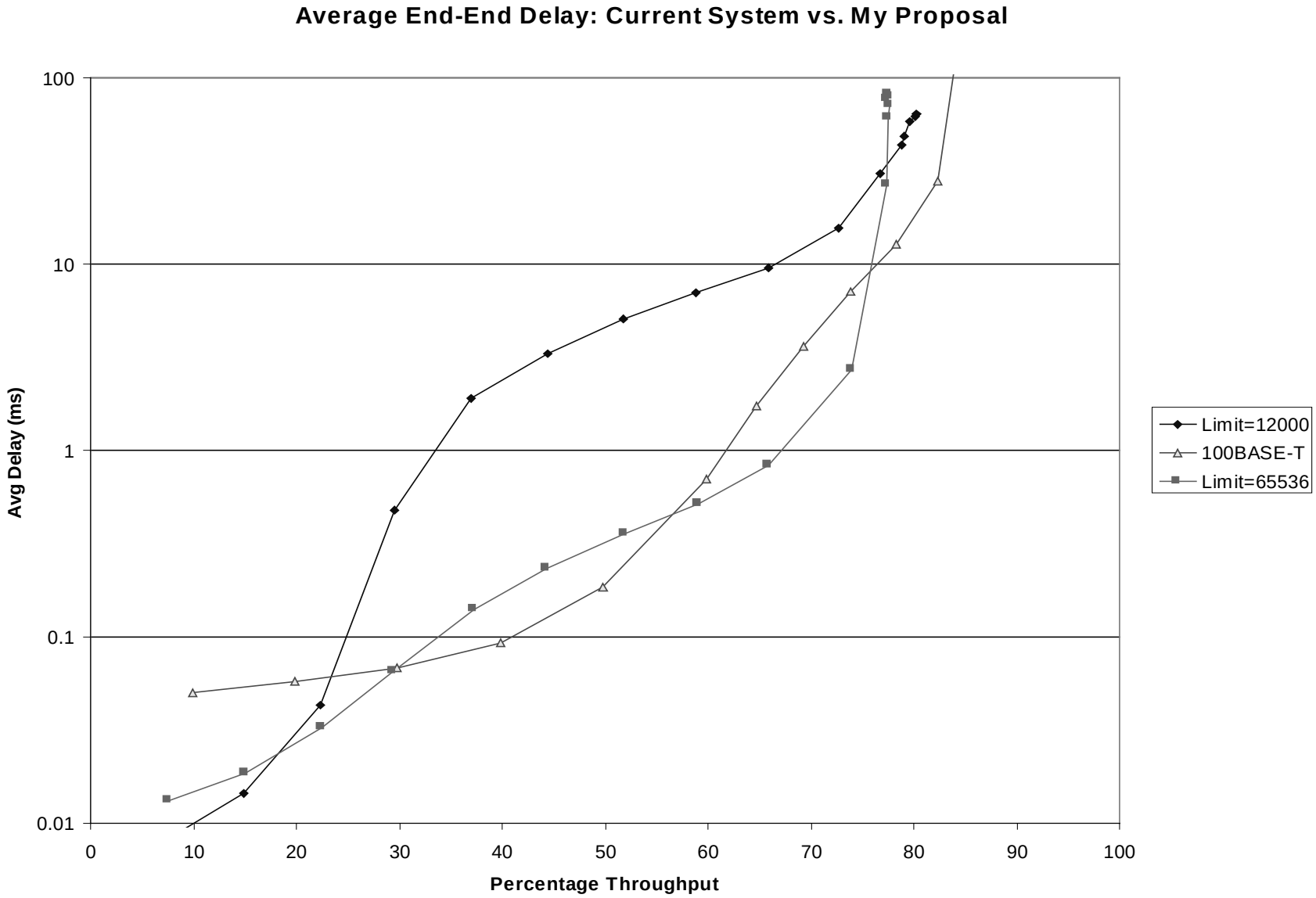
- Long propagation delay hurts efficiency
  - carrier extension and frame bursting help
- Delays are large / unpredictable at high load
  - BLAM can help smooth the traffic flow
- Not important any more because of Buffered Distributor
  - but what are their relative costs?

We are Very Close to a Viable Half-Duplex CSMA/CD System

- Pat Thaler suggested increasing the burst limit beyond 12,000 bit times for efficiency
  - Defining it as a power of 2 would also make it easier to implement
- Mohan Kalkunte and I studied this for BEB
  - increasing the burst length has a small effect on efficiency
  - it does no harm to other performance measures

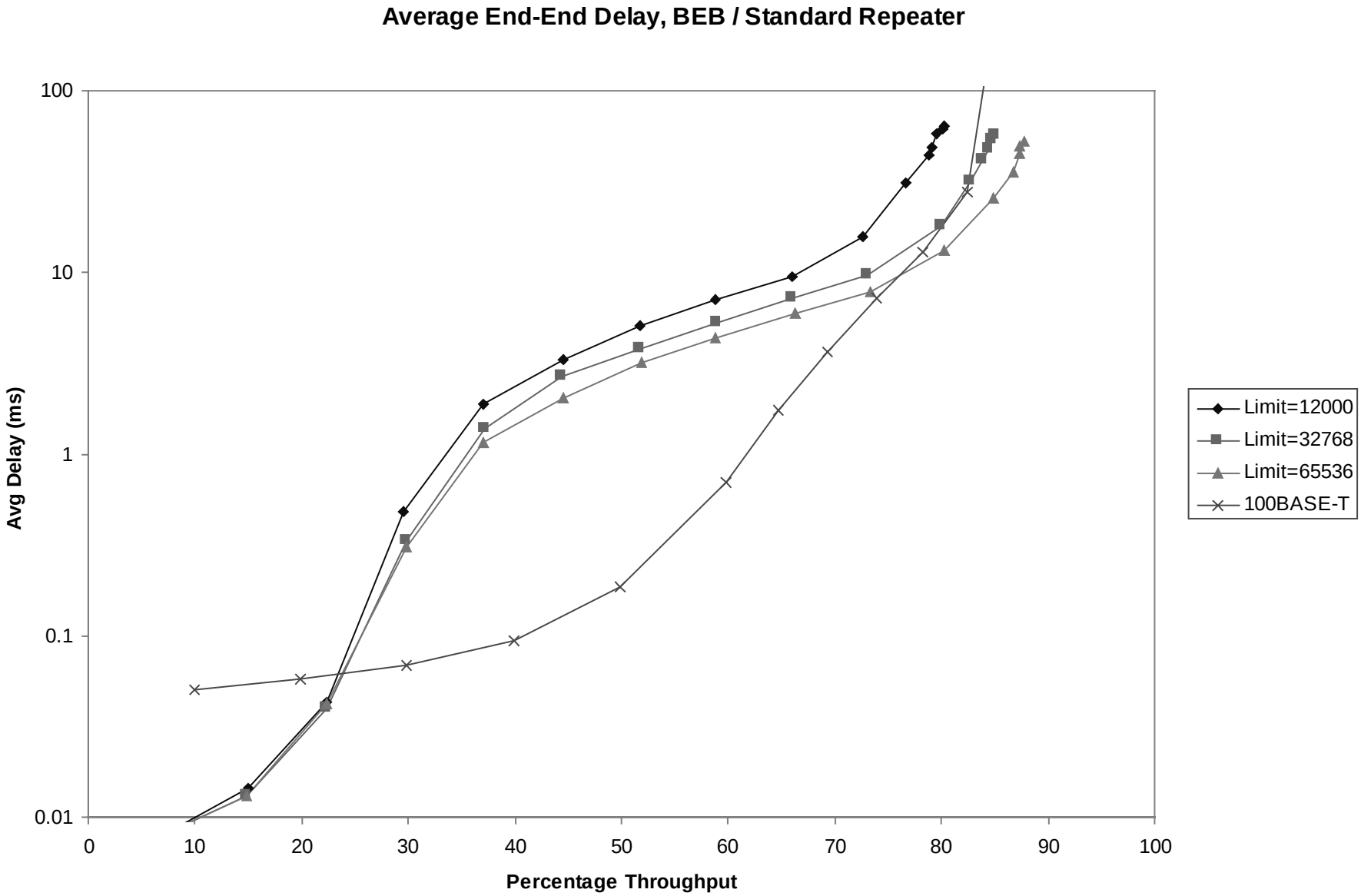
Effect of Burst Limit on BLAM

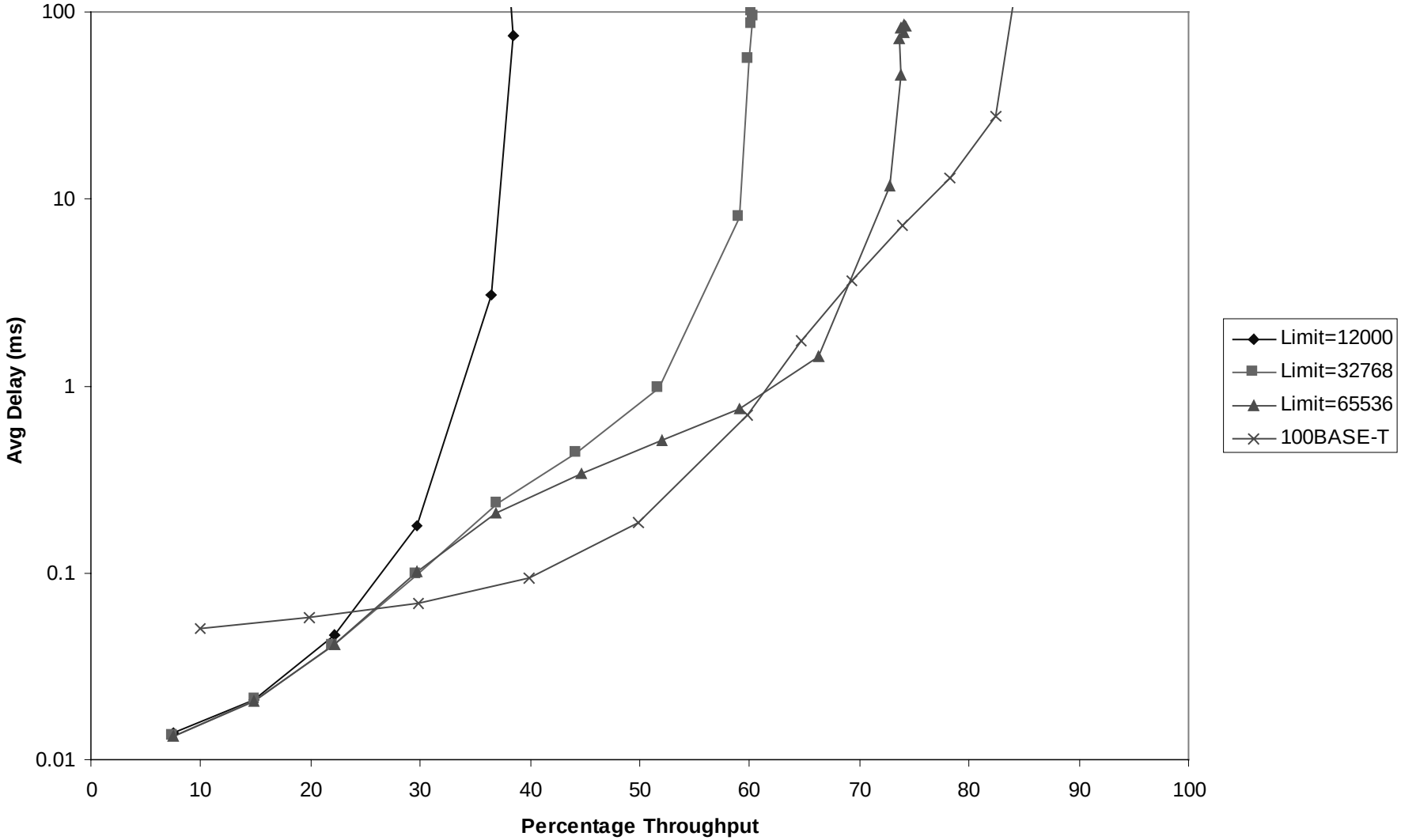
- Bad News:
  - BLAM's frequent collisions during arbitration make its performance sensitive to the slot time
- Good News:
  - Increasing the burst limit from 1500 bytes (12,000 bits) to 8 kilobytes (65,535 bits) literally *doubles* its efficiency!
  - Delay is *ten times lower* than current proposal


Average End-End Delay: Current System vs. My Proposal
Avg Delay (ms)
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage Throughput
Limit=12000
100BASE-T
Limit=65536

Proposal #1: Increase burst limit to 8 kilobytes

- Allows BLAM to attain almost 80% efficiency with the “work group average” packet size distribution
- This is tiny compared to BEB capture effect
  - mean BLAM burst length is 14 at 75% load
  - mean BEB burst length is >100 at 50% load
- When compared to 100BASE-T, this gives *ten times more throughput at the same delay*


Average End-End Delay, BEB / Standard Repeater
Avg Delay (ms)
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage Throughput
Limit=12000
Limit=32768
Limit=65536
100BASE-T


Average End-End Delay, BLAM / Standard Repeater
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1
0.1
0.01
0
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70
80
90
100
Percentage Throughput
Limit=12000
Limit=32768
Limit=65536
100BASE-T

Proposal #2: Allow Collision Truncation in the Repeater

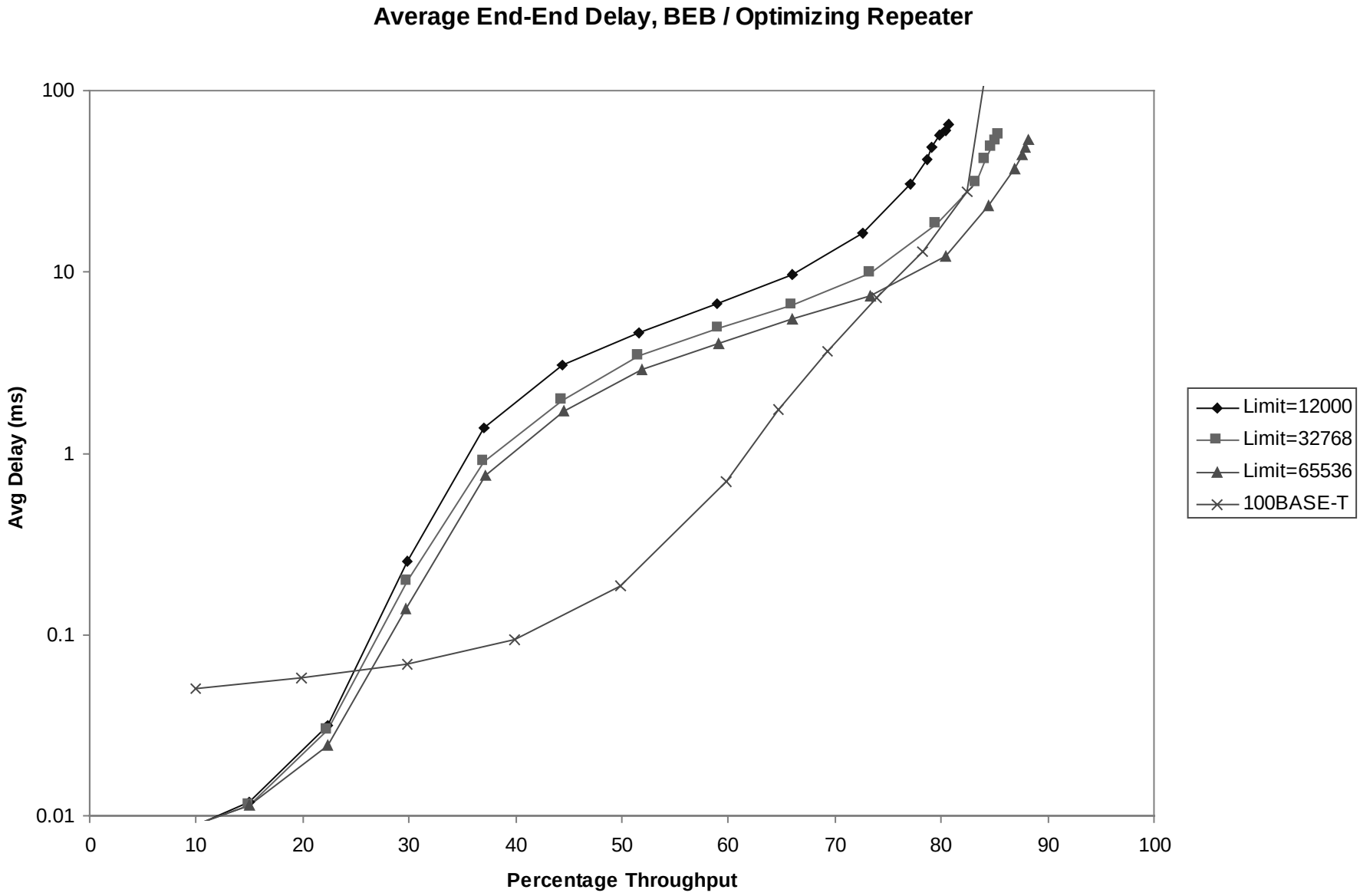
- I introduced collision truncation in my talk at the March 1996 IEEE Plenary
- The idea is a small change to the repeater port that “hides” the end of an incoming collision signal from the core state machine
- Requires no changes to the MAC
- The stations think the network is smaller

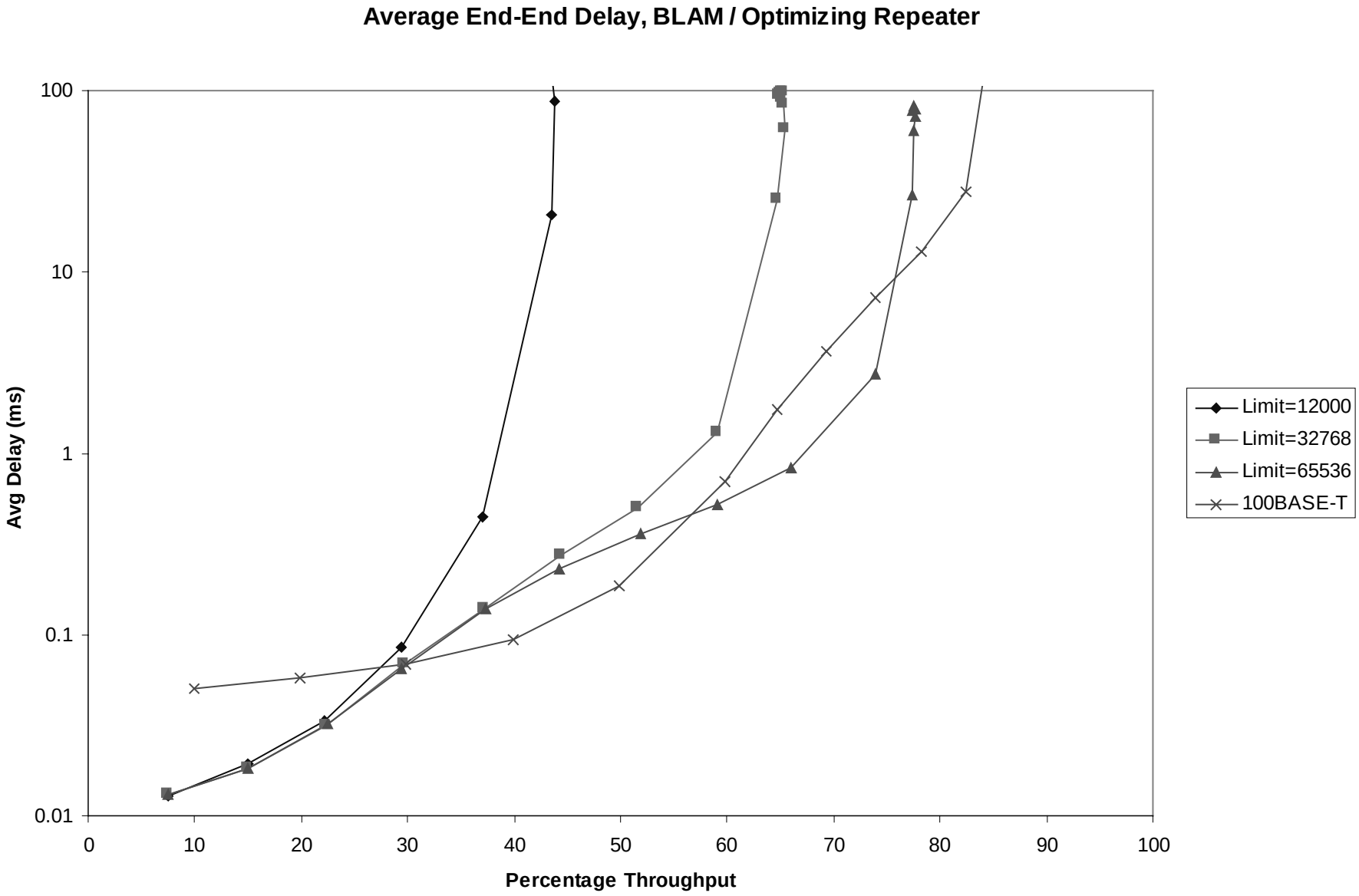
Effect of Collision Truncation on Performance

- My student Boaz Yeger and I implemented a detailed repeater model with and without the collision truncation feature
- Tested it on a network with round-trip delay of 4000 bit times
- Model was set up to measure collision sizes, catch late collisions and other errors

Results

- Average collision event cut in half:
  - minimum 96 2032
  - maximum 2096 4032
  - average 590.3 2667.5
- Average delay for BEB drops in low load:
  - @30%: 0.25msec 0.48msec
- Maximum throughput of BLAM increases:
  - @64KB: 77.5% 74%


Average End-End Delay, BEB / Optimizing Repeater
100
10
1
0.1
0.01
Avg Delay (ms)
0
10
20
30
40
50
60
70
80
90
100
Percentage Throughput
Limit=12000
Limit=32768
Limit=65536
100BASE-T


Average End-End Delay, BLAM / Optimizing Repeater
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Conclusions

- Viable half-duplex CSMA/CD + repeater products are possible
- We should make the necessary changes to the 802.3z standard to support this:
  - increase the burst length to 8 Kilobytes
  - make sure the timing specifications for the repeater do not preclude a *negative* delays in responding to collisions