

TCP AND ATM IN WIDE AREA NETWORKS

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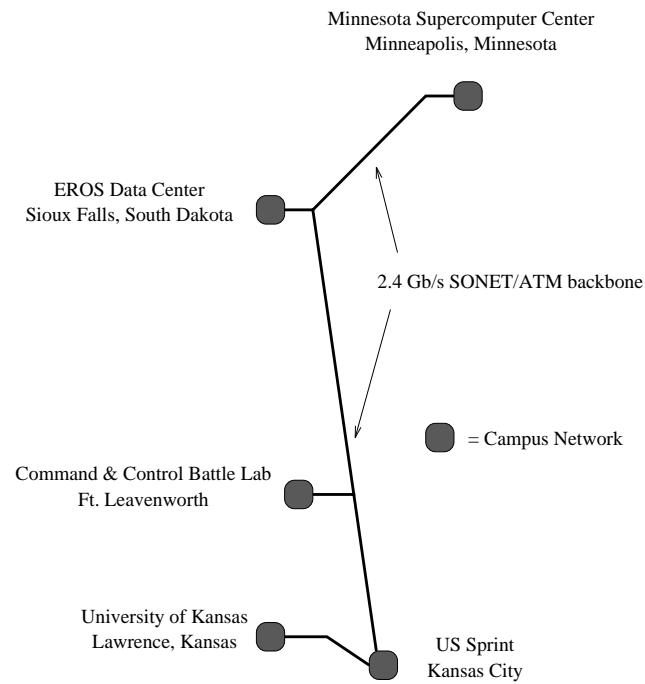
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INTRODUCTION

INTRODUCTION

MAGIC Network

- 2.4 Gb/s Wide-Area Network (1000 kilometers)
- support for 622 Mb/s (OC-12c) and 155 Mb/s (OC-3c) circuits
- hosts at KU, BCBL, Sprint, EDC used for tests



Overview of Results

- default TCP/IP performance over ATM WAN is poor
 - buffer overflow caused by bandwidth mismatch, multiple sources
 - TCP rate control not working?
 - TCP windows must be large enough for WAN
- solutions
 - ATM
 - TCP

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EXPERIMENTS

EXPERIMENTS**Experiment 1**

- question: WAN performance limited by TCP window size?
- experiment: DEC Alpha with a DEC OTTO OC-3c interface to DEC Alpha over a 600 km link, 8.8 ms round-trip delay
- results

TCP Window Size	0.5k	1k	2k	4k	8k	16k	32k	64k	128k
Throughput (Mb/s)	0.47	0.93	1.8	3.7	7.4	14.9	29.8	59.6	119

- comments
 - consistent with the theoretical limits caused by latency
 - pacing not needed because no rate mismatch
 - large windows necessary for acceptable throughput

Experiment 2

- questions: high bandwidth TCP sources will overrun ATM switch buffers at points of bandwidth mismatch? improved by pacing?
- experiment: Alpha (OC-3c) in Lawrence, Kansas to SPARC-10 (TAXI) in South Dakota (600 km) - a single host to another host
 - Alphas - DEC OTTO cards, SPARC-10 - Fore Systems 100 Mb/s TAXI
 - switches - Fore Systems ASX-100
 - 128 kB TCP windows, 64 kB write buffers
 - ATM pacing at 70 Mb/s
- results:

No Pacing	Pacing
0.87 Mb/s	68.20 Mb/s

Experiment 3

- questions: multiple high bandwidth TCP sources will overrun ATM switch buffers at multiplexing points? improved using pacing?
- experiment: Two Alphas (OC-3c) in Lawrence, Kansas to SPARC-10 (TAXI) in South Dakota (600 km) - two hosts to a third host
 - Alphas - DEC OTTO cards, SPARC-10 - Fore Systems 100 Mb/s TAXI, switches - Fore Systems ASX-100
 - 128 kB TCP windows, 64 kB write buffers
 - ATM pacing at 35 Mb/s each
- results:

No Pacing	Pacing
1.66 Mb/s	52.36 Mb/s

Experiment 4

- questions: interoperability? packet losses? pacing effects?
- experiment:
 - scenario a: two SPARC-10s (TAXI) in Kansas and South Dakota to SGI Onyx (TAXI) in Kansas City - Fore interfaces only
 - scenario b: two Alphas (OC-3c) in Lawrence, Kansas to SGI Onyx (TAXI) in Kansas City - two hosts supporting pacing to a third host

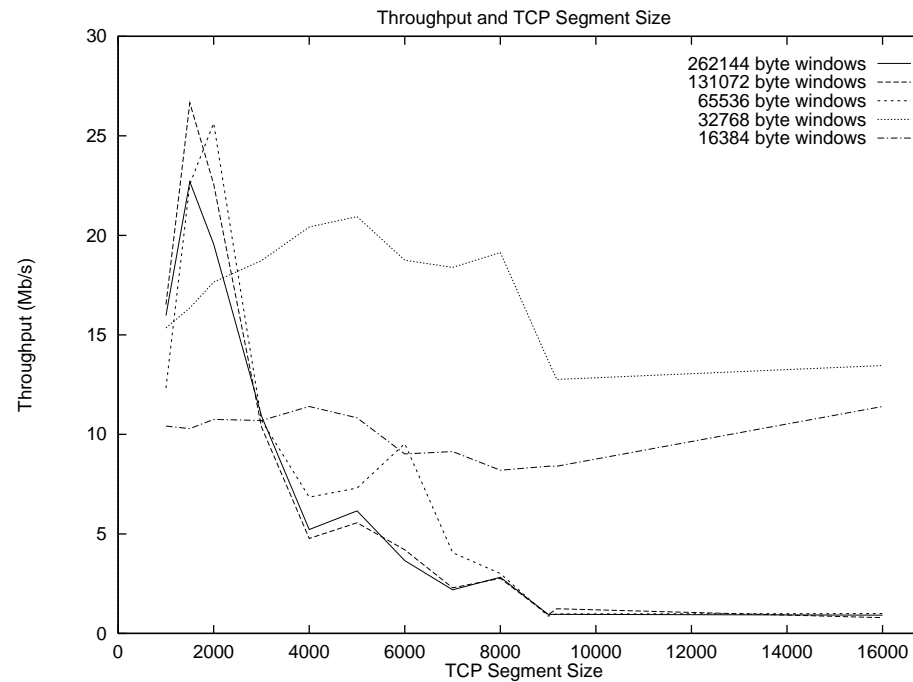
- results:

	No Pacing	Pacing
scenario a	46.71 Mb/s	-
scenario b	-	61.17 Mb/s

- comments:
 - two to four packet losses per second observed in scenario a
 - no packet losses observed in scenario b

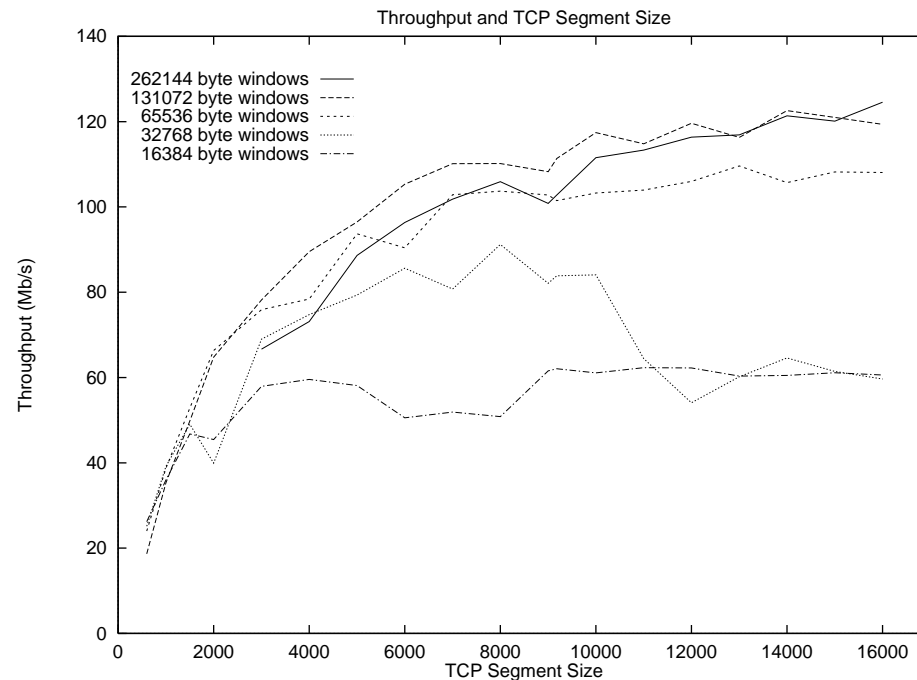
Experiment 5

- question: will TCP rate control be more effective if TCP segment size small relative to buffers?
- experiment: Alpha (OC-3c) in Lawrence, Kansas to SPARC-10 (TAXI) in South Dakota (600 km), vary TCP segment size
- results:



Experiment 6

- question: does TCP performance trade-off exist due to congestion limits versus machine processing limits?
- experiment: Alpha (OC-3c) in Lawrence, Kansas to Alpha (OC-3c) at same location, vary TCP segment size
- results:



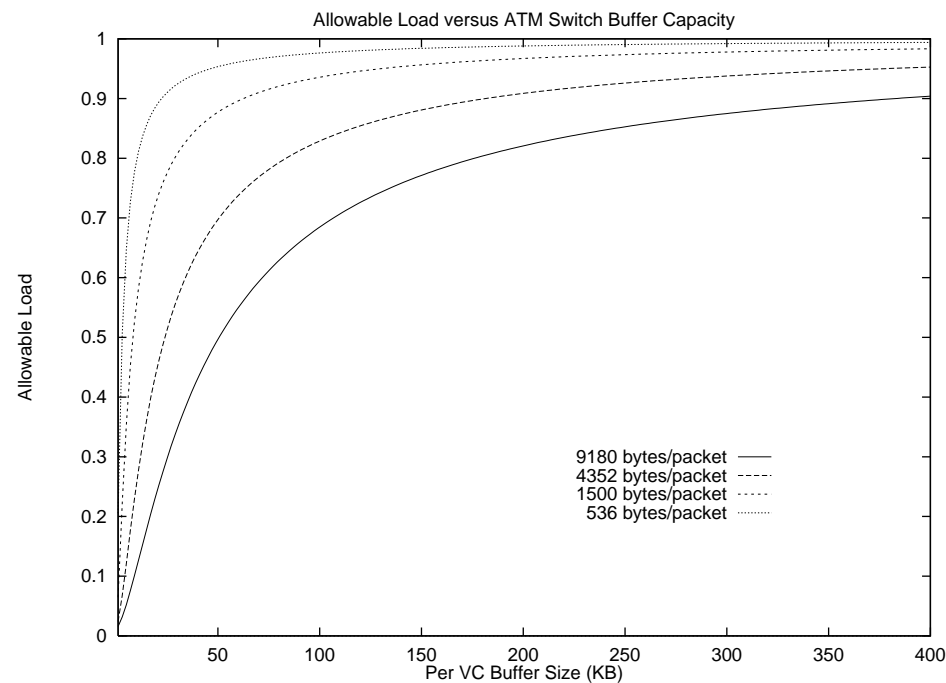
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EXTRAPOLATION

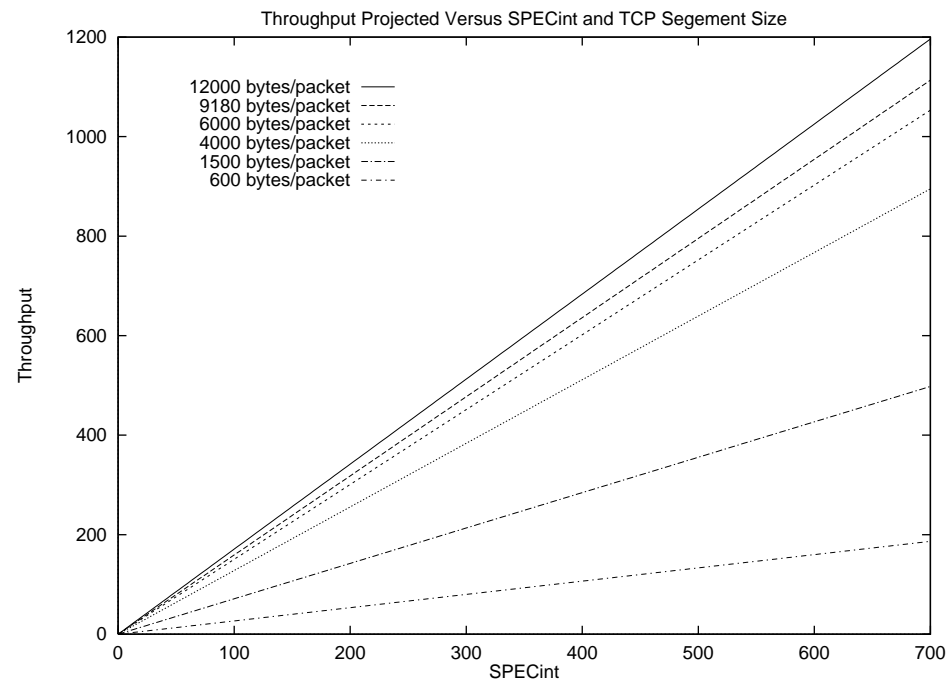
EXTRAPOLATION**Buffer Size Effects**

- segment size and buffers (Fore ASX-100 has 12 kB buffer)
- assume given cell loss rate, find buffers needed for given load



TCP Processing Bounds

- throughput limits due to segment size and machine speed
- extrapolate from measured data to higher machine capabilities



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CONCLUSION

CONCLUSION

- congestion limitations
- WAN limitations
- processing limitations
- ATM pacing
- TCP pacing