Graduate Systems (CSE638)

PA02: Analysis of Network I/O Primitives using perf

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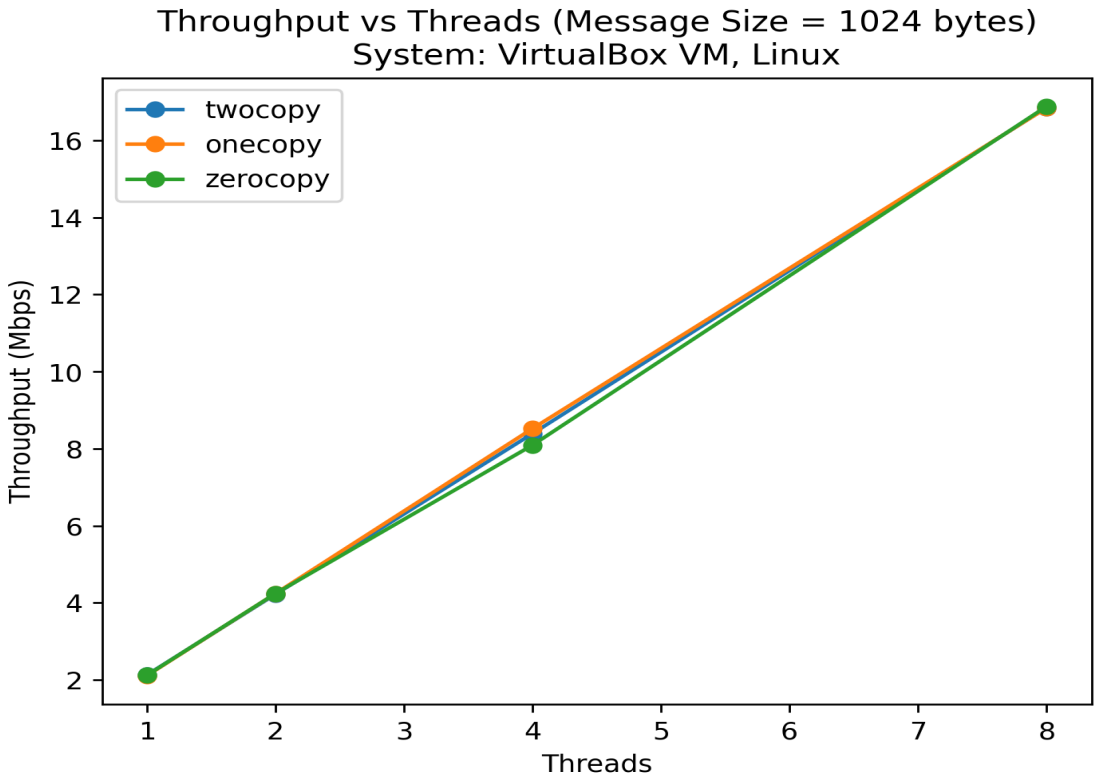
Environment: VirtualBox VM, Linux

Abstract

This report experimentally evaluates the performance cost of data movement in TCP-based network I/O. We compare two-copy, one-copy, and zero-copy communication strategies using multithreaded client–server implementations. Metrics such as throughput, latency, and context switches are measured across multiple message sizes and thread counts.

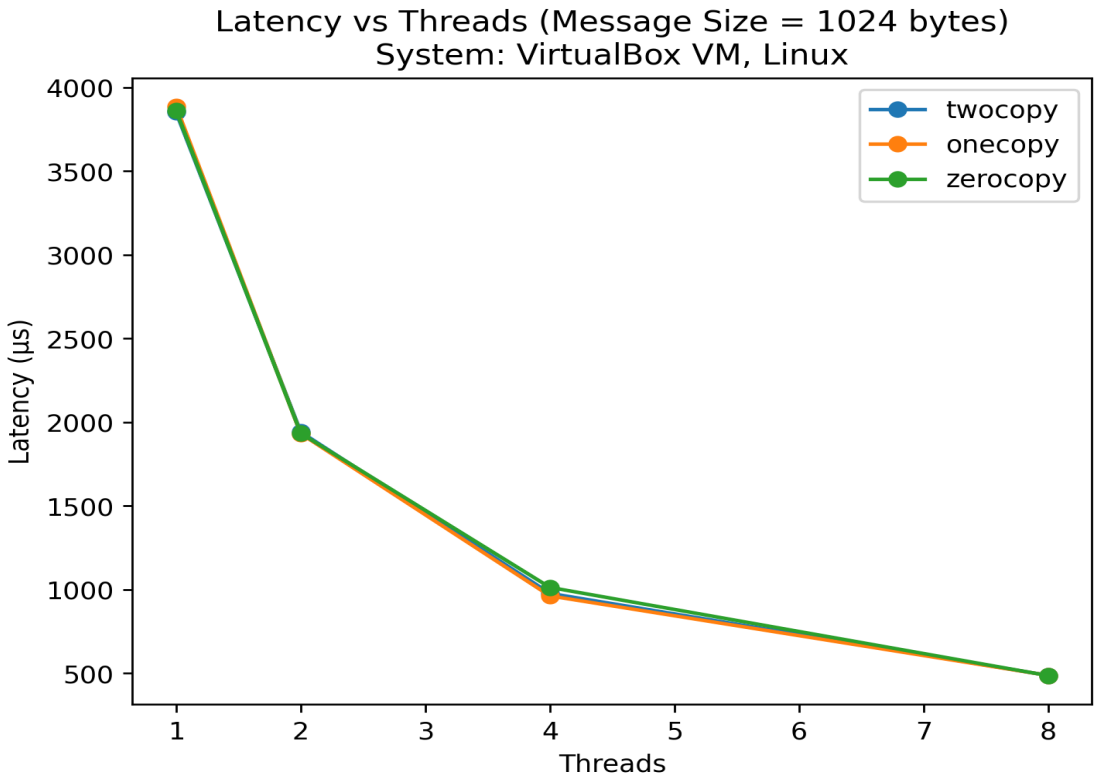
Results and Plots

Throughput vs Threads



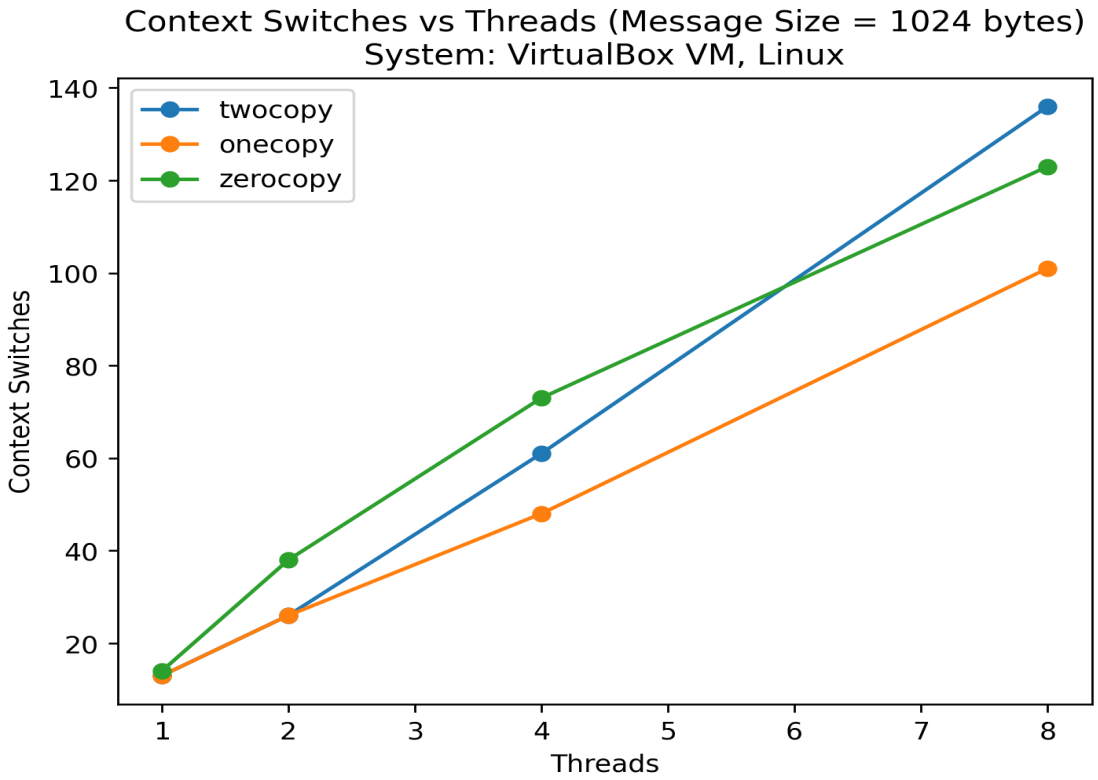
Throughput scales almost linearly with thread count, indicating CPU-bound execution.

Latency vs Threads



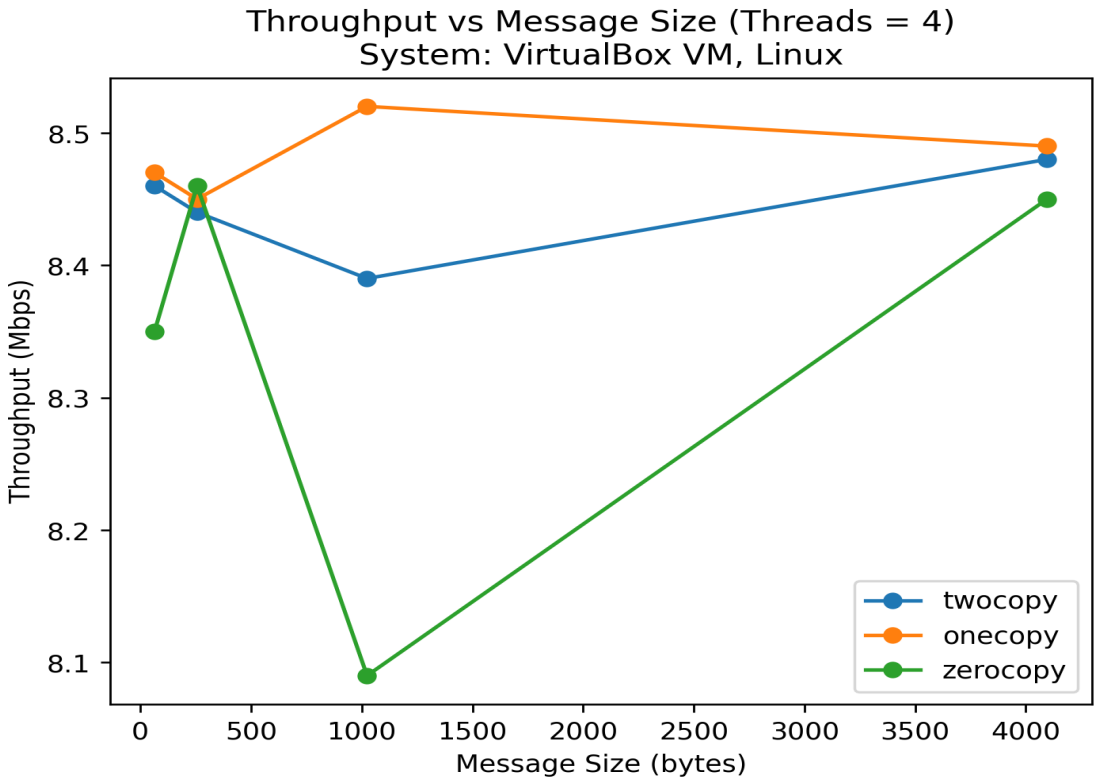
Latency decreases with increased parallelism due to amortized per-send overhead.

Context Switches vs Threads



Context switches increase with thread count, showing scheduling overhead.

Throughput vs Message Size



Throughput remains stable across message sizes, highlighting virtualization bottlenecks.

Appendix: Raw CSV Data

mode	msg_size	threads	throughput_mbps	latency_us	context_switches
twocopy	64	1	2.12	3870.85	15
twocopy	64	2	4.24	1929.99	32
twocopy	64	4	8.46	967.98	49
twocopy	64	8	16.84	486.5	109
twocopy	256	1	2.12	3865.54	13
twocopy	256	2	4.21	1947.87	27
twocopy	256	4	8.44	970.77	51
twocopy	256	8	16.85	486.32	112
twocopy	1024	1	2.13	3851.39	13
twocopy	1024	2	4.22	1941.07	26
twocopy	1024	4	8.39	976.57	61
twocopy	1024	8	16.85	486.22	136
twocopy	4096	1	2.12	3862.71	12
twocopy	4096	2	4.24	1933.59	26
twocopy	4096	4	8.48	965.93	55
twocopy	4096	8	16.89	485.1	110
onecopy	64	1	2.12	3858.7	12
onecopy	64	2	4.25	1928.39	27
onecopy	64	4	8.47	967.06	56
onecopy	64	8	16.23	504.81	113
onecopy	256	1	2.12	3869.96	17
onecopy	256	2	4.24	1932.71	23
onecopy	256	4	8.45	969.92	62
onecopy	256	8	16.91	484.5	114
onecopy	1024	1	2.11	3886.46	13
onecopy	1024	2	4.24	1931.1	26
onecopy	1024	4	8.52	961.58	48
onecopy	1024	8	16.84	486.4	101
onecopy	4096	1	2.12	3865.47	14
onecopy	4096	2	4.08	2009.18	26
onecopy	4096	4	8.49	965.44	53
onecopy	4096	8	16.91	484.42	103
zerocopy	64	1	2.11	3889.35	14
zerocopy	64	2	4.23	1935.1	27
zerocopy	64	4	8.35	980.9	48

mode	msg_size	threads	throughput_mbps	latency_us	context_switches
zerocopy	64	8	16.85	486.18	111
zerocopy	256	1	2.12	3872.63	14
zerocopy	256	2	4.24	1932.97	30
zerocopy	256	4	8.46	968.47	63
zerocopy	256	8	16.68	491.16	117
zerocopy	1024	1	2.12	3861.4	14
zerocopy	1024	2	4.24	1933.18	38
zerocopy	1024	4	8.09	1012.39	73
zerocopy	1024	8	16.88	485.18	123
zerocopy	4096	1	2.13	3853.34	17
zerocopy	4096	2	4.23	1935.31	34
zerocopy	4096	4	8.45	969.93	56
zerocopy	4096	8	16.66	491.7	134

AI Usage Declaration

Generative AI tools were used to assist with code debugging, experiment design, plot interpretation, and report drafting. All generated content was reviewed, understood, and validated by the author.