Performance Comparison of Virtual Machines and Linux Containers[1]

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[1] An Updated Performance Comparison of Virtual Machines and Linux Containers IBM Research Report

背景

- 本 文 选 取 一 组 Benchmark ， 从 CPU 、 memory 、 storage 、 networking 四个维度，比较Native、Docker、Kvm性能

- 结果表明Container几乎在所有测试场景中， 性能接近Native，优于VM

Benchmark

比较对象	Native Docker KVM	
测试负载	负载	负载类型
压力测试负载	CPU-PXZ	压缩计算
	HPC-Linpack	浮点数计算
	STREAM	内存带宽
	RandomAccess	内存随机访问
	nuttcp	网络吞吐量
	netperf	网络延迟
	fio	磁盘I/O
实际负载	Redis	Redis负载
	Mysql	Mysql负载

实验结果：CPU和内存

TABLE I. RESULTS FOR PXZ, LINPACK, STREAM, AND RANDOMACCESS. EACH DATA POINT IS THE ARITHMETIC MEAN OF TEN RUNS. DEPARTURE FROM NATIVE EXECUTION IS SHOW WITHIN PARENTHESES "()". THE STANDARD DEVIATION IS SHOWN WITHIN SQUARE BRACKETS "[]".

Workload		Native	Docker	KVM-untuned	KVM-tuned
PXZ (MB/s)		76.2 [±0.93]	73.5 (-4%) [±0.64]	59.2 (-22%) [±1.88]	62.2 (-18%) [±1.33]
Linpack (GFLOPS)		290.8 [±1.13]	290.9 (-0%) [±0.98]	241.3 (-17%) [±1.18]	284.2 (-2%) [±1.45]
RandomAccess (GUPS)		0.0126 [±0.00029]	0.0124 (-2%) [±0.00044]	0.0125 (-1%) [±0.00032]	Tuned run not warranted
Stream (GB/s)	Add	45.8 [±0.21]	45.6 (-0%) [±0.55]	45.0 (-2%) [±0.19]	
	Copy	41.3 [±0.06]	41.2 (-0%) [±0.08]	40.1 (-3%) [±0.21]	
	Scale	41.2 [±0.08]	41.2 (-0%) [±0.06]	40.0 (-3%) [±0.15]	
	Triad	45.6 [±0.12]	45.6 (-0%) [±0.49]	45.0 (-1%) [±0.20]	

- Docker的CPU计算能力接近于Native，优于VM 20%
- Docker，Native，VM的内存访问速度接近相同

实验结果：网络吞吐量和延迟

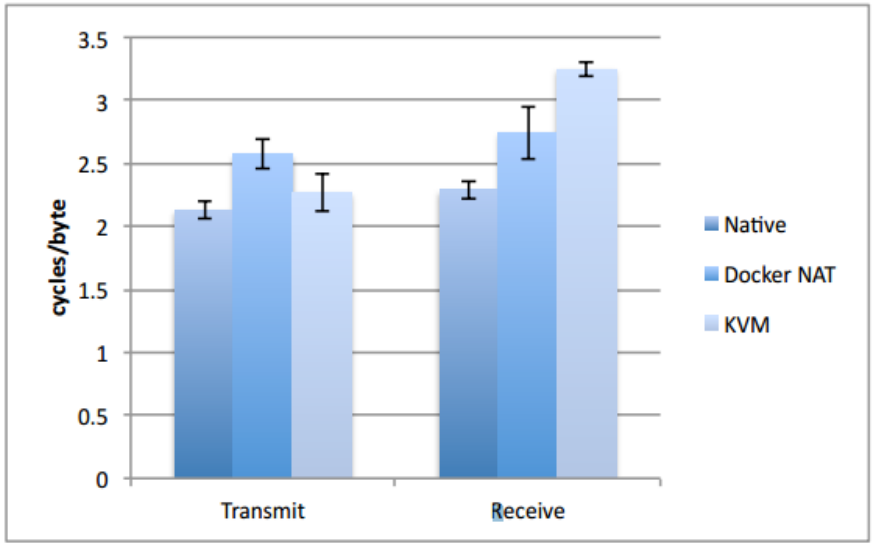

Fig. 2. TCP bulk transfer efficiency (CPU cycles/byte)

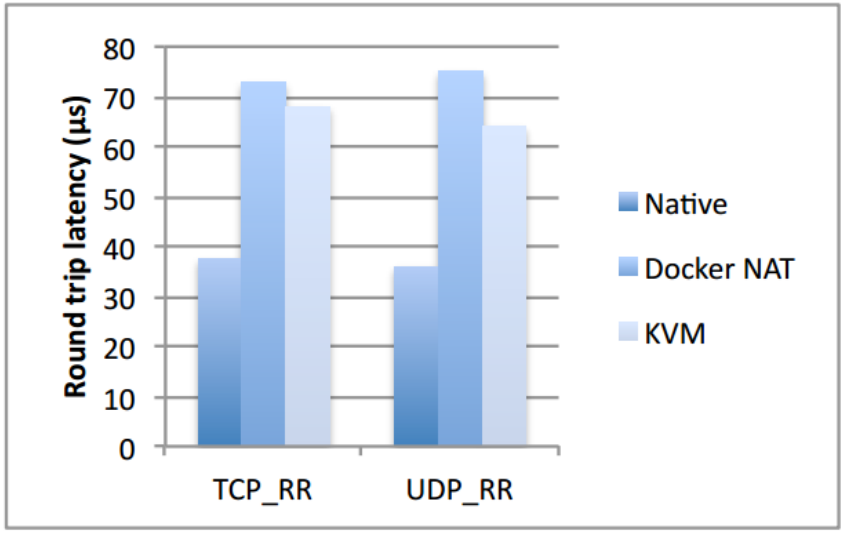

Fig. 3. Network round-trip latency (μs).

- Docker网络性能接近于KVM，差于Native

实验结果：磁盘I/O

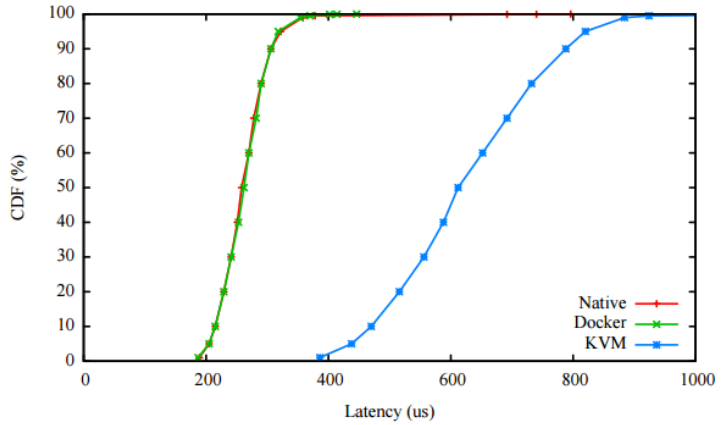

Fig. 7. Random read latency CDF, concurrency 16 (μs). The Native and Docker lines are almost superimposed atop one another.

Fig. 4. Storage configurations used for `fio`

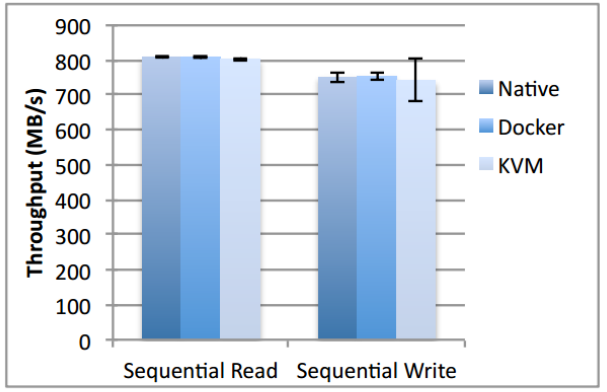

Fig. 5. Sequential I/O throughput (MB/s).

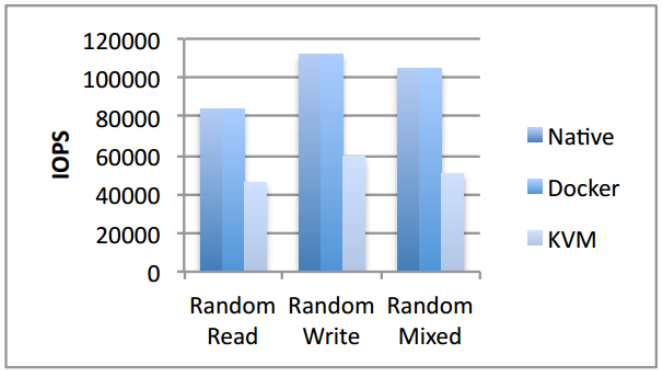

Fig. 6. Random I/O throughput (IOPS).

- Docker的磁盘I/O接近于Native，远远优于KVM

实验结果：NoSQL Redis负载

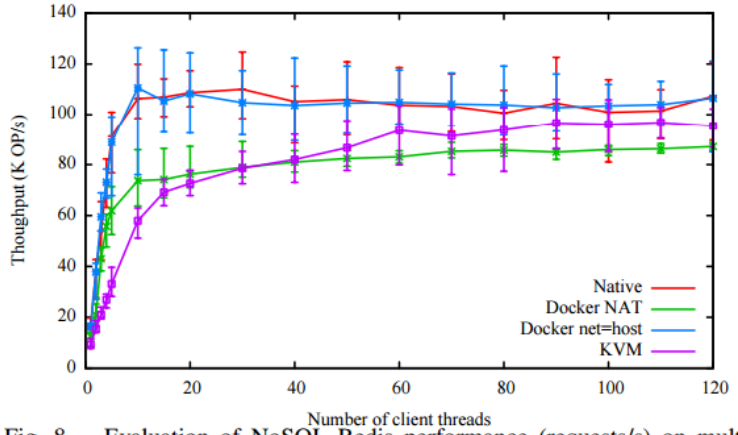

Fig. 8. Evaluation of NoSQL Redis performance (requests/s) on multiple deployment scenarios. Each data point is the arithmetic mean obtained from 10 runs.

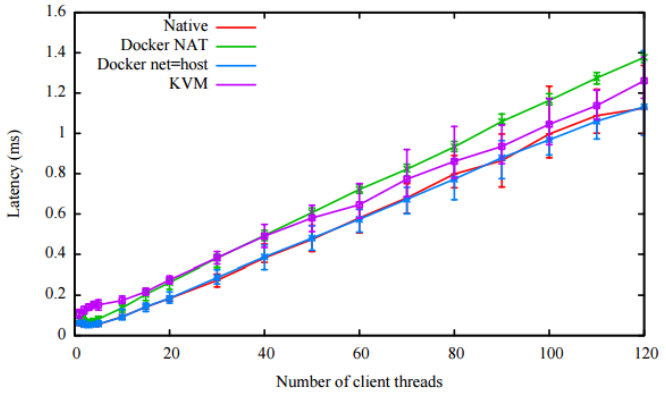

Fig. 9. Average latency (in ms) of operations on different Redis deployments. Each data point is the arithmetic mean obtained from 10 runs.

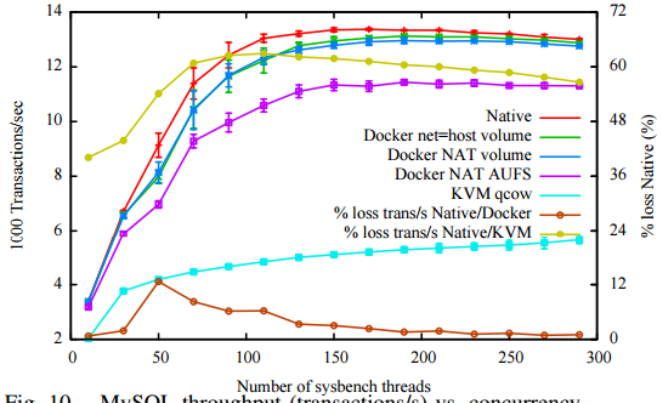

Fig. 10. MySQL throughput (transactions/s) vs. concurrency.

- Redis负载运行在Docker上的性能接近于Native，优化KVM

实验结果：SQL负载

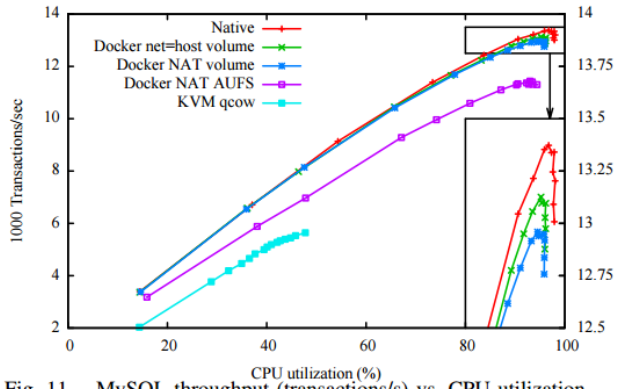

Fig. 11. MySQL throughput (transactions/s) vs. CPU utilization.

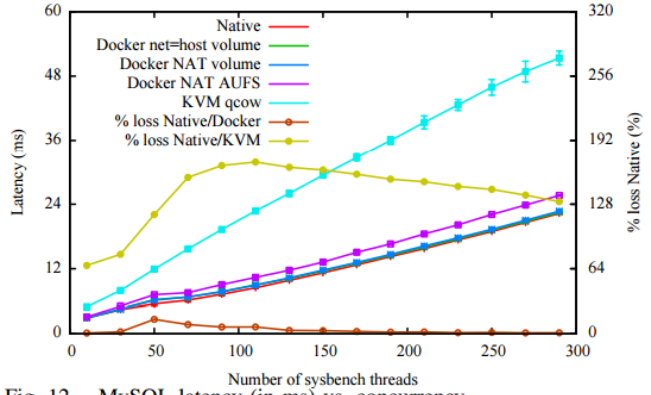

Fig. 12. MySQL latency (in ms) vs. concurrency.

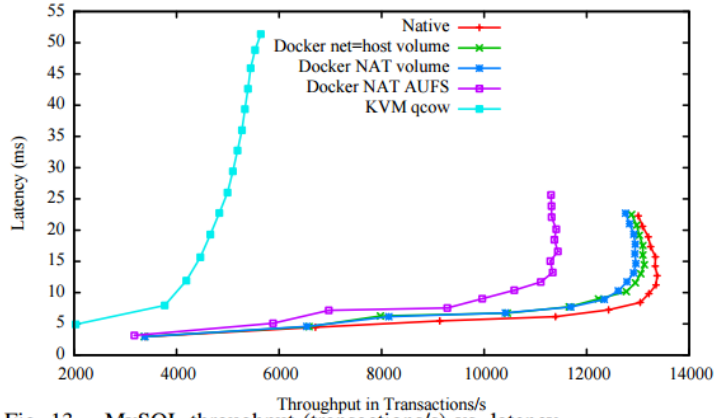

Fig. 13. MySQL throughput (transactions/s) vs. latency.

- SQL负载运行在Docker性能接近于Native，优于KVM

总结

- 本文选取一组Benchmark和实际负载，从多个维度比较Native、Docker、Kvm性能，结果表明Docker几乎在所有测试场景中，性能接近Native，优于VM