Public Cloud Performance

MEASUREMENT REPORT

This report compares the block storage offerings of well-known public clouds (Amazon AWS, Google Cloud, Microsoft Azure, Linode and OVHcloud) with a number of StorPool-based public cloud offerings.

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Introduction

In these public cloud performance tests, StorPool aimed to assess the block storage offerings of several public clouds - Amazon AWS, Google Cloud, Microsoft Azure, Linode, and OVHcloud - and compare them against Katapult, a StorPool-based public cloud. To the best of our ability, we've selected VM instance types and everything else in the configurations to be identical. Therefore, we have an apples-to-apples comparison of only the underlying storage systems/offerings, adjusted for other aspects like memory where needed.

All tested systems are in production clusters and part of generally available public cloud offerings, so our results are easily reproducible. The Katapult system is part of a production public cloud, so results on this service are directly comparable to results from the big five public clouds.

About Katapult and the StorPool implementation in Krystal's infrastructure

Katapult is a virtual Infrastructure as a Service platform designed for extreme performance and simplicity. The solution is developed by Krystal, one of the largest independent UK web hosting companies. Katapult implements best-of-breed technologies and years of successful expertise in the cloud domain, backed up by an exceptional level of service.

Krystal selected StorPool because of its high performance, robust API, unique space-saving features and extremely high level of data protection delivered by its triple data replication.

"Storage forms the bedrock of any cloud platform, so whatever you use has to be bulletproof. At Krystal we've always had a standard rule; buy the very best solution available and sleep well at night! This is especially true when it comes to our clients' data, which is the most important thing we look after."

Simon Blackler, CEO of Krystal

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We performed 4 types of tests:

1. **PGBENCH** - a database benchmark, perhaps closest to "application performance"
2. **Sysbench/MySQL** - a second database benchmark for control of PGBENCH results
3. **fio** - a set synthetic benchmarks — random reads/writes, sequential reads/writes, latency measurements
4. **rsync** - copying files and syncing, simulating rapid deployment and backup workloads

Among these tests, we consider PGBENCH and Sysbench/mysql to be most representative of real-world transactional workloads (including most web applications).
The remaining fio and rsync tests are somewhat further away from being representative of real-world applications. They serve as a synthetic measure of the ideal latency or maximum throughput possible with each storage technology.

The Virtual Machines

We procured 6 virtual machines with identical parameters from all tested clouds. We selected medium-sized VMs with 16 GB RAM and 8 dedicated vCPUs to represent a medium-sized database server (the system at the heart of many web applications).

Date of test	Provider	Instance name	Region	Montly cost (with 12 month commitment)	vCPUs	RAM
2020 10	Katapult	ROCK-24	London	$120	8	24GB*
2020 11	AWS	Compute optimized: c5.2xlarge	us-east-2	$245	8	16GB
2020 11	Google Cloud	General purpose: n2-8vcpu-16gb	us-central1	$197	8	32GB*
2020 11	Microsoft Azure	Compute optimized: Standard_F8s_v2 - 8 vcpus, 16 GiB memory	East US	$235	8	16GB
2021 11	Linode	Dedicated CPU 8vcpu/16GB	Newark NJ	$120	8	16GB
2021 11	OVHcloud	CPU optimized c2-30	gra9	$143	8	30GB*

* – the VM procured from Katapult, Google Cloud and OVHcloud had more than the 16GB memory required for this test. We adjusted for the difference by pre-allocating the excess memory as a file in /dev/shm.

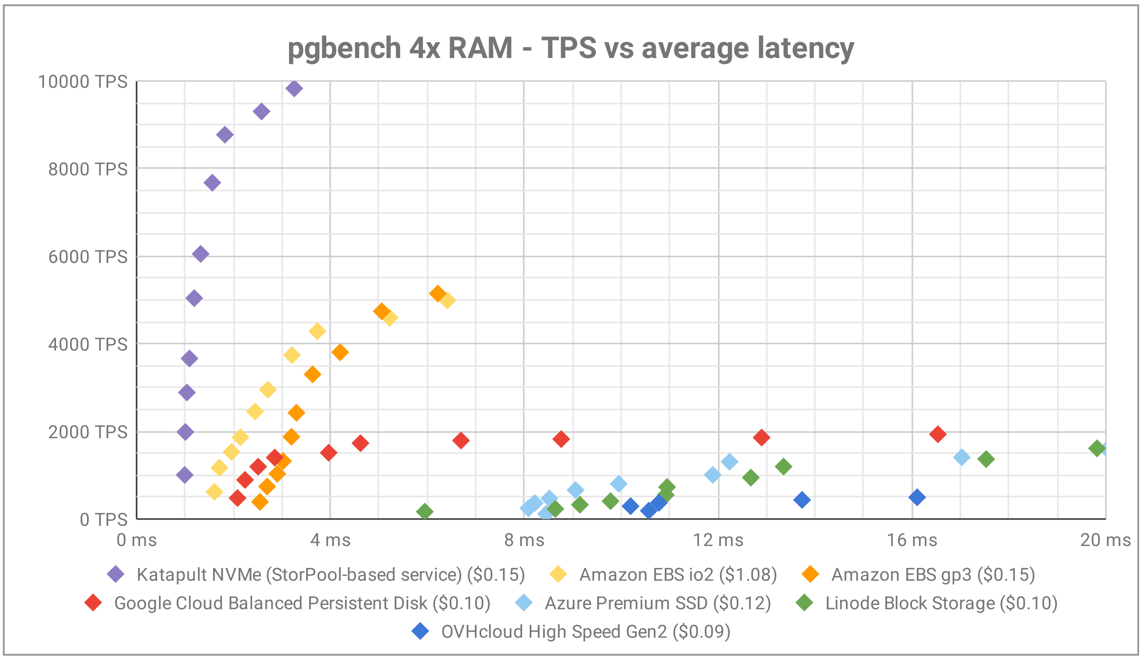
The Storage Volumes

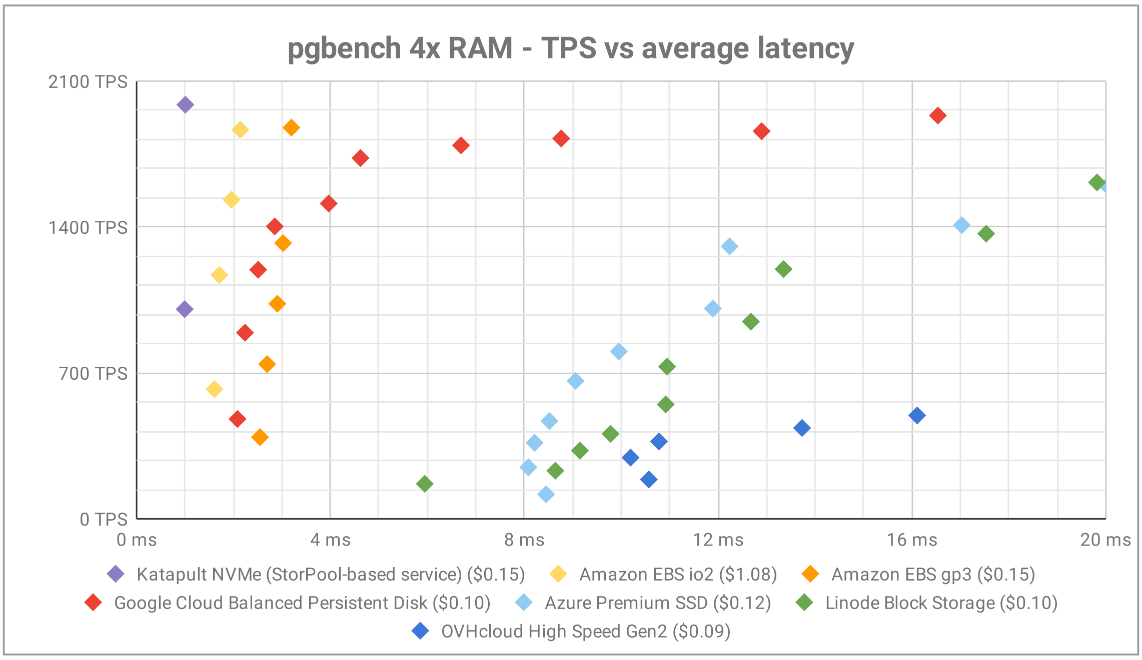
We procured block storage volumes associated with each VM, attached to the VMs as virtual disks. The goal here was to give each provider a fair chance with their SSD-based block storage offering. We procured an over-sized 1TB virtual disk in all clouds, even though typical databases on a VM of this size would be 50-200GB, to ensure that clouds that have a per GB IOPS limit would not be severely limiting in our testing. This skews the results in favour of the big 4 clouds. In the StorPool-based clouds our customers either don't apply an IOPS limit or have a very high IOPS limit to allow each VM to receive high performance for short periods of time. Katapult provisions customer volumes with no IOPS limit. This is typical usage for a StorPool system. The StorPool system delivers a very high IOPS capability, so the usual strategy used by our customers is to use IOPS limits only as a policing action to combat abuse.

Provider	Service name	$/GiB/ month	IOPS limit	Size of volume [GiB]	Monthly cost
Katapult	Shared disk NVMe	$0.15	unlimited	1024	$154
Amazon EBS io2	Provisioned IOPS SSD (io2) Volumes	$1.08	15,000	1024	$1,103
Amazon EBS gp3	EBS gp3	$0.10	15,000	1024	$157
Google Cloud	Balanced Persistent Disk	$0.10	6,144	1024	$102
Microsoft Azure	Premium SSD	$0.12	3,500	1024	$123
Linode	Block Storage	$0.10	unlimited	1024	$102
OVHcloud	High Speed Gen2	$0.09	20,000	1024	$92

PGBENCH Large DB

• Simulate a large OLTP (transactional) database — most web and mobile apps
• "On-Disk Test" settings from Postgresql Wiki
• Dataset is 64GB, i.e. 4x RAM
• Number of threads (-j parameter) is one-half of the number of clients
• The number of clients (-c parameter) is varied between 1 (simulating light load and lowest latency) and 32 (simulating more than maximum recommended production load for an 8 vCPU database). – Reference for test scenario and parameters.
https://wiki.postgresql.org/wiki/Pgbenchtesting#Memory_vs._Disk_Performance





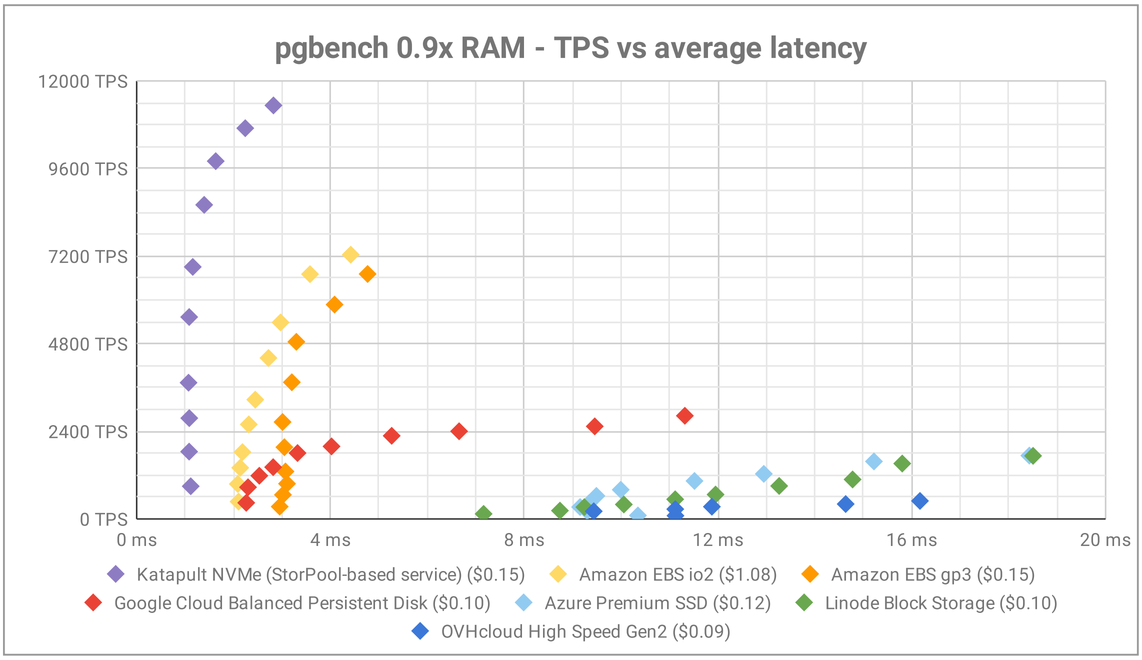
Presented as two charts at different zoom levels to make sure the very different results are clearly visible.

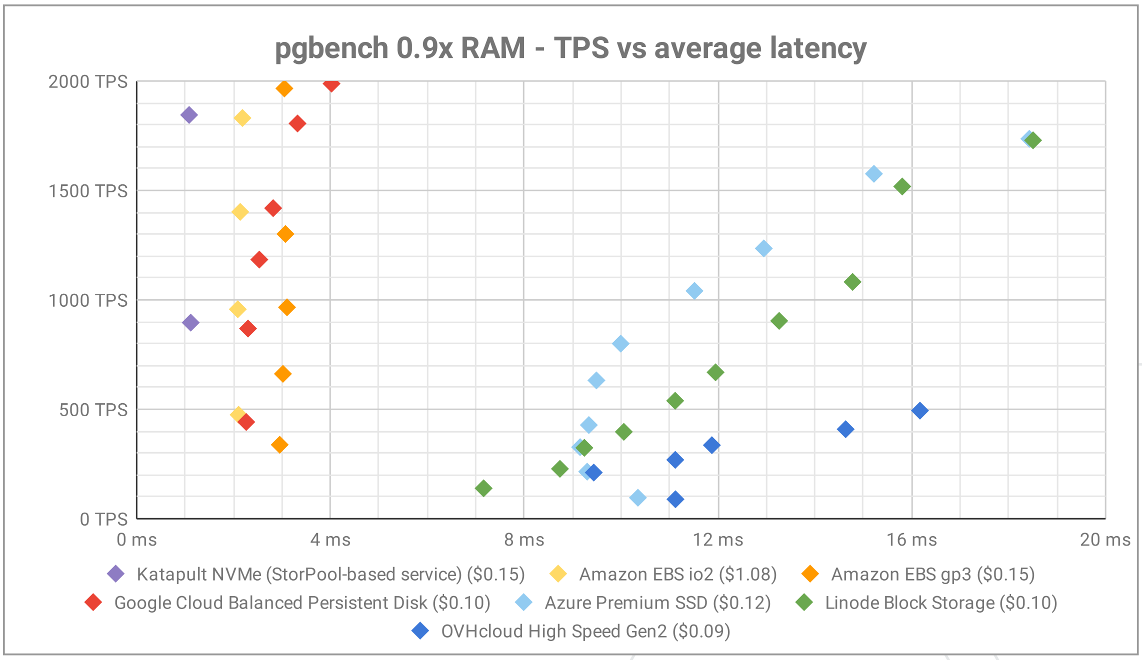
These graphs show extreme differences in the performance of the database on the 6 different VMs. We investigated what causes these large differences by running pair experiments (higher vs lower IOPS limit, higher speed CPU vs slower CPU). The differences don't seem to be caused by CPU or memory. The fundamental difference observed is attributable to differences in storage performance and behaviour.

On the same storage system, an **IOPS limit** generally controls how many TPS we can get at large latency (suitable for batch processing) but **does not directly affect latency under a fixed transactional load**. For example, if you have a fixed load of 2,000 TPS, the Katapult NVMe configuration (StorPool-based) would deliver a transaction latency of 1 ms and Google Cloud approx 7ms. The difference between these latencies is almost wholly attributable to storage system latency.

PGBENCH Small DB

• Simulate a small OLTP (transactional) database — most web and mobile apps
• “Mostly Cached” settings from Postgresql Wiki
• Dataset is 14.4GB, i.e. 0.9x RAM
• Number of threads (-j parameter) is one-half of number of clients
• The number of clients (-c parameter) is varied between 1 (simulating light load and lowest latency) and 32 (simulating more than the maximum recommended production load for a 8 vCPU database).
• Reference for test scenario and parameters
https://wiki.postgresql.org/wiki/Pgbenchtesting#Memory_vs._Disk_Performance





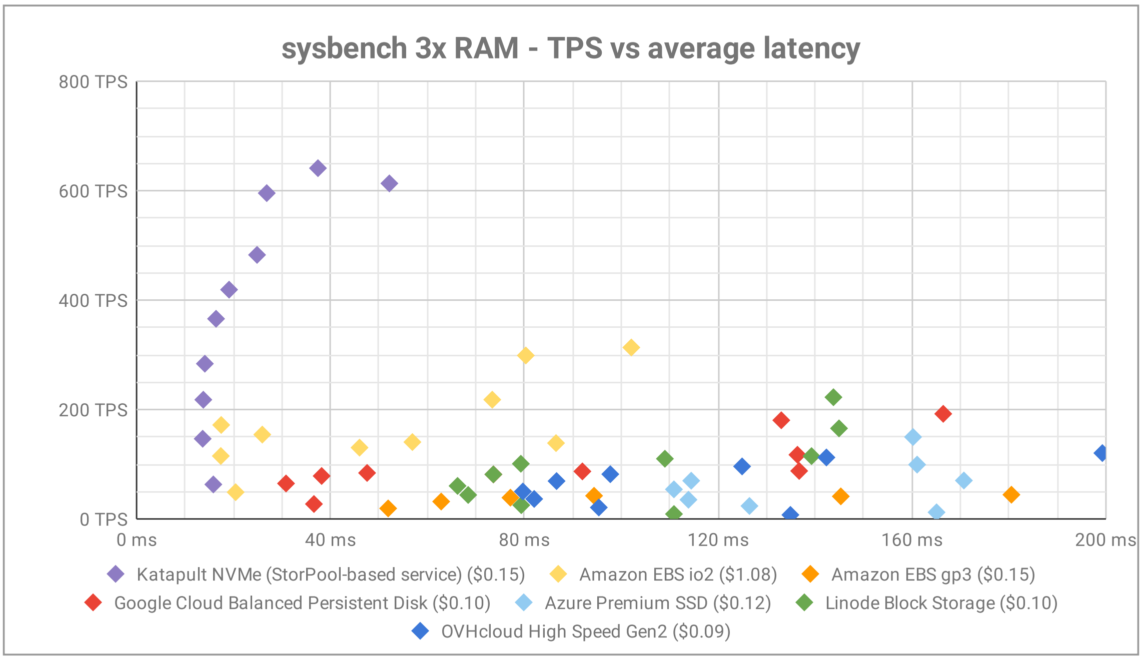
Again presented at two zoom levels.

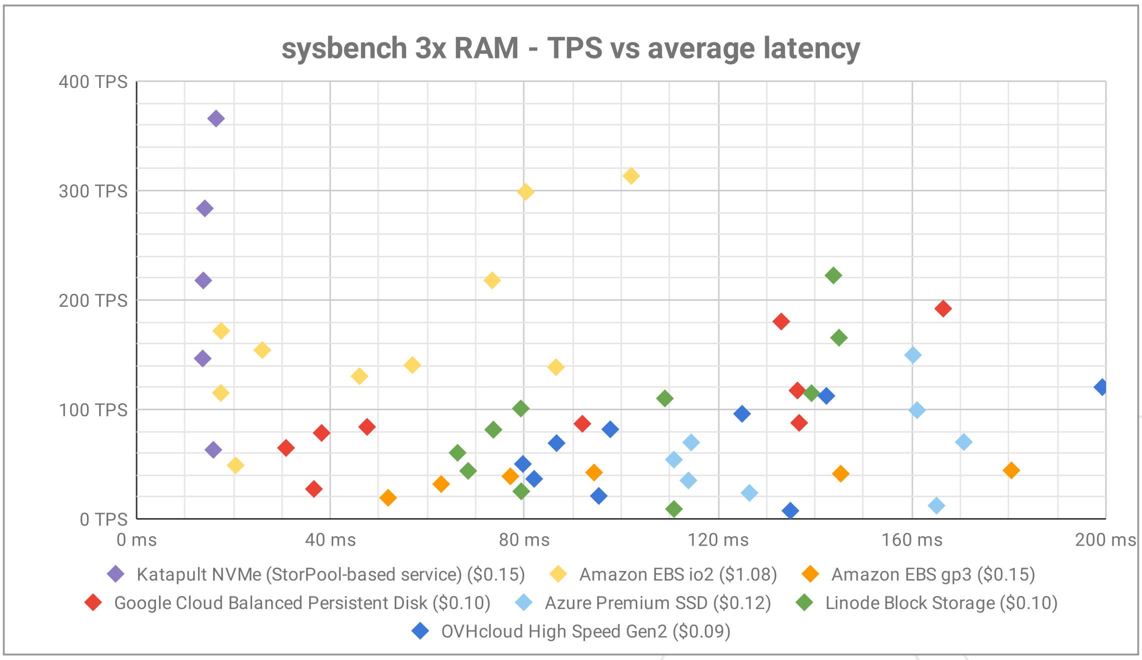
Even when a database is smaller than RAM, the storage system’s performance greatly influences the database.

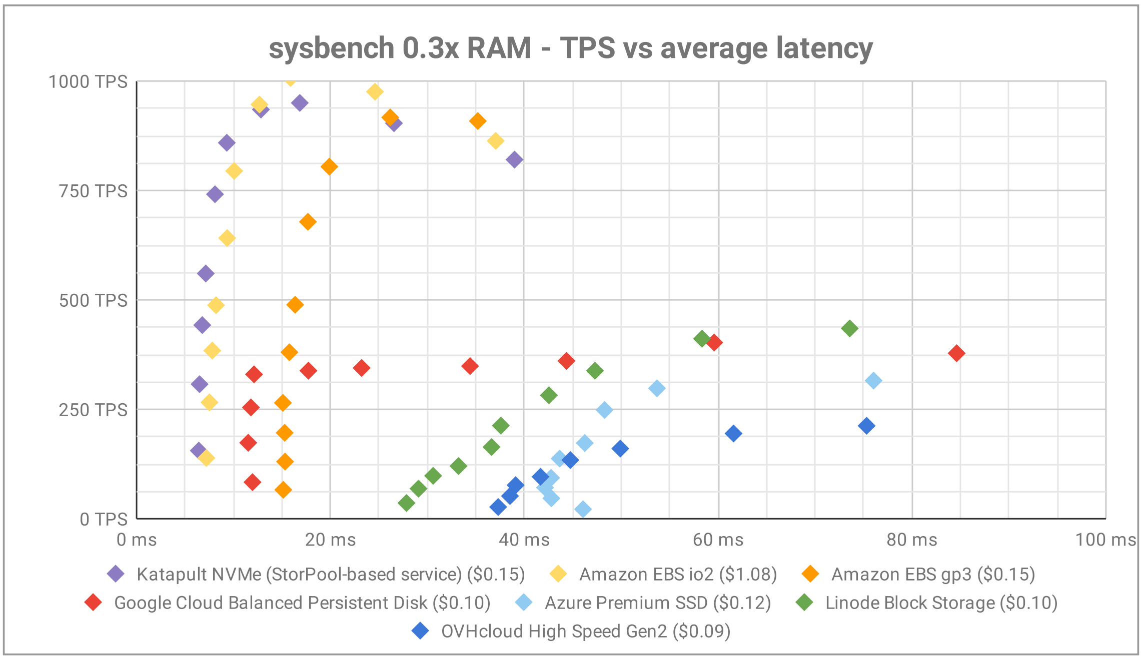
Sysbench/MySQL

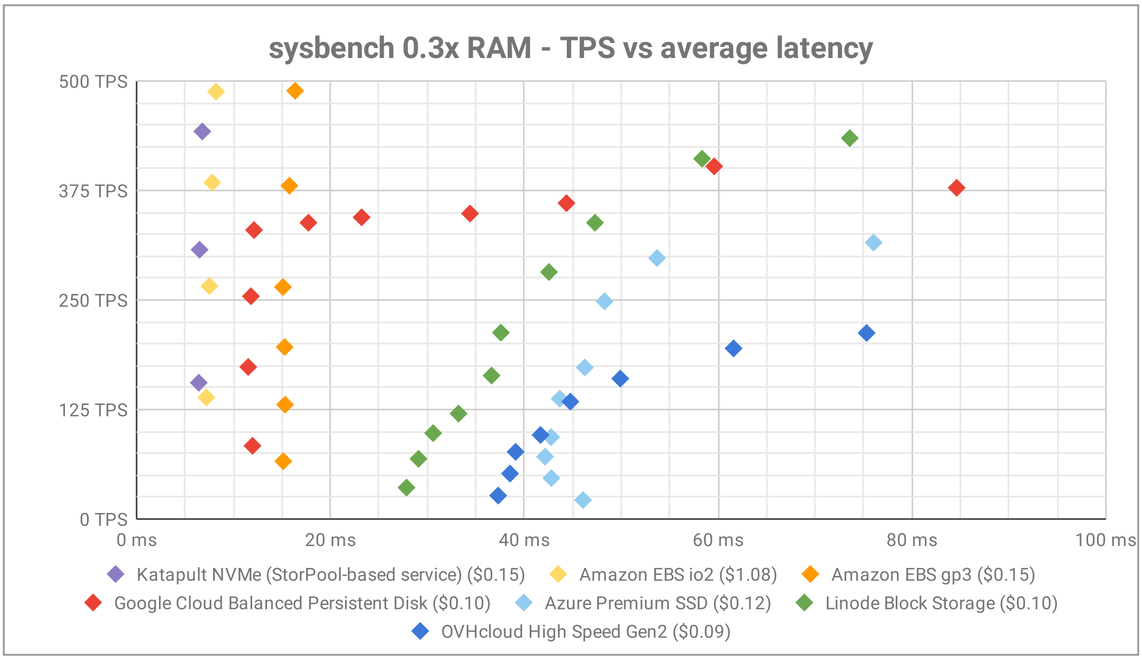
We ran Sysbench with a MySQL database, for control over the PGBENCH results. This shows that the results and extreme differences are reproducible with a completely different benchmark and database stack.

The database sizes are 50GB and 5GB, respectively.









From these charts, it's clear that, for large MySQL-like databases, the Katapult offering stands out as the only solution that can serve many clients at consistently low latencies. Meanwhile, for small databases, the only offering capable of keeping up with the Katapult service levels is the Amazon EBS io2 storage which comes at 7 times the cost of the Katapult all-NVMe storage.

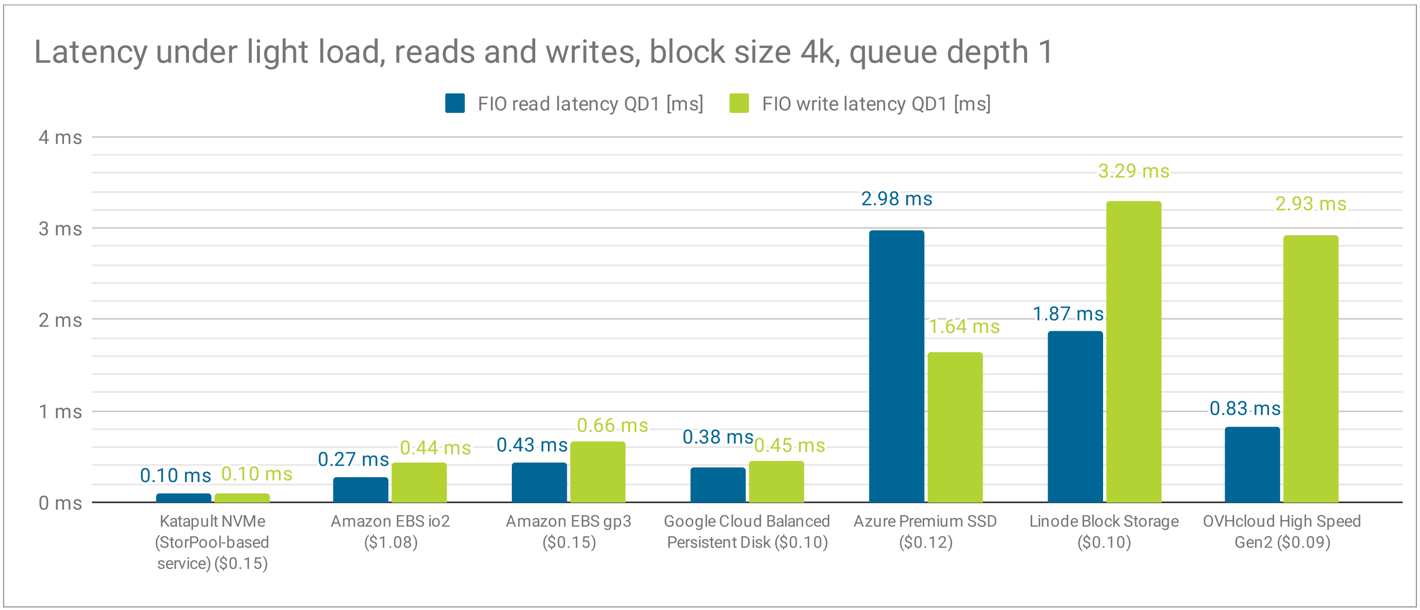
FIO Tests

We ran the usual suite of synthetic benchmarks, which show the performance envelope of the tested services.

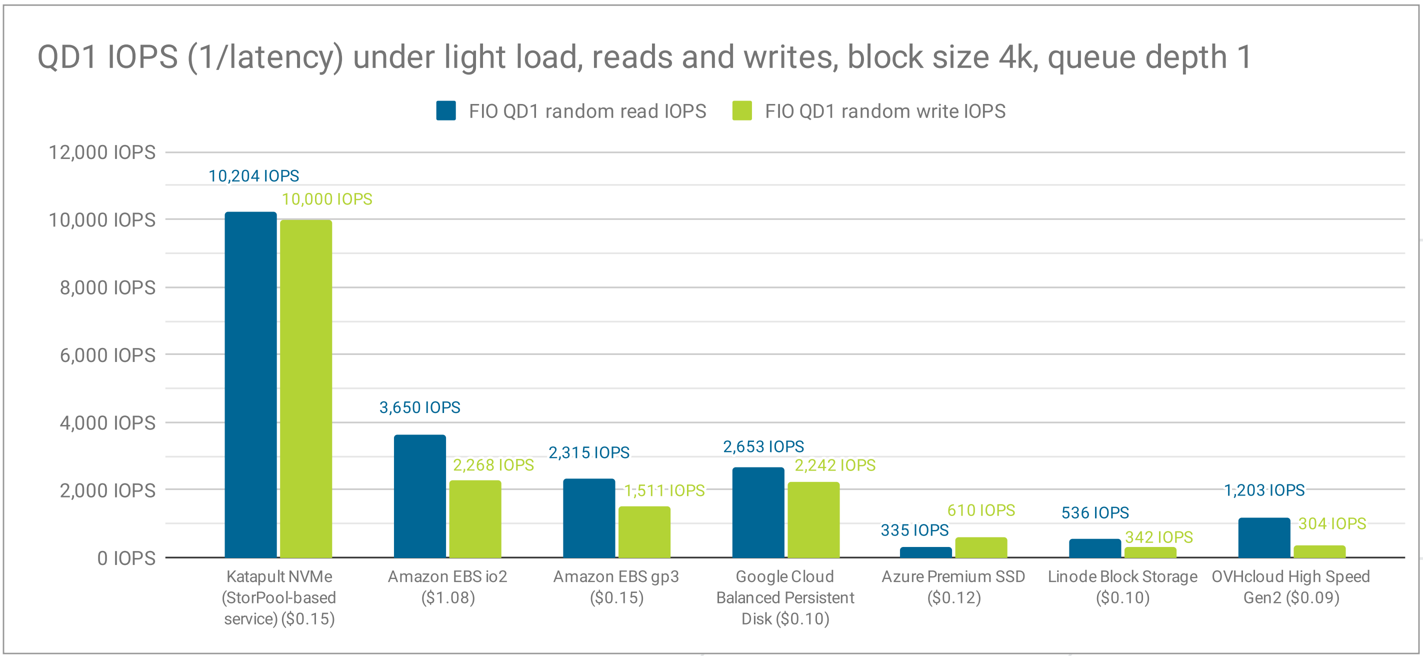
These are:
• random 4k queue depth 1 – for latency under light load
• random 4k queue large queue depth – for IOPS throughput
• sequential workload with large queue depth – for MB/s throughput

FIO Latency

• Transactional workload
• Random read; random write
• Block size 4k
• Queue depth 1
• Simulates small transactional workload
• The poor results on these tests of Azure, Linode and OVHcloud, especially for writes are the most likely reason PGBENCH and Sysbench/MySQL are getting so low results on these services.

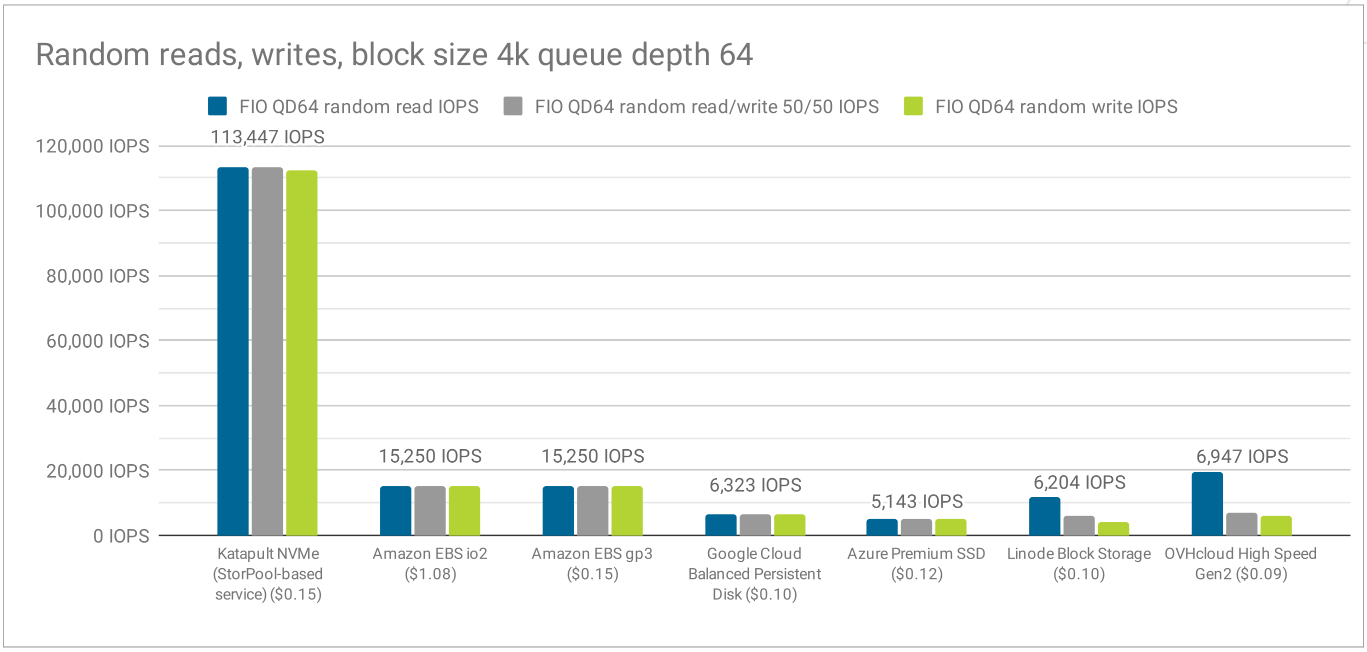


We also present the queue depth 1 result as IOPS (1/latency) to make comparing the top performers easier (higher is better):



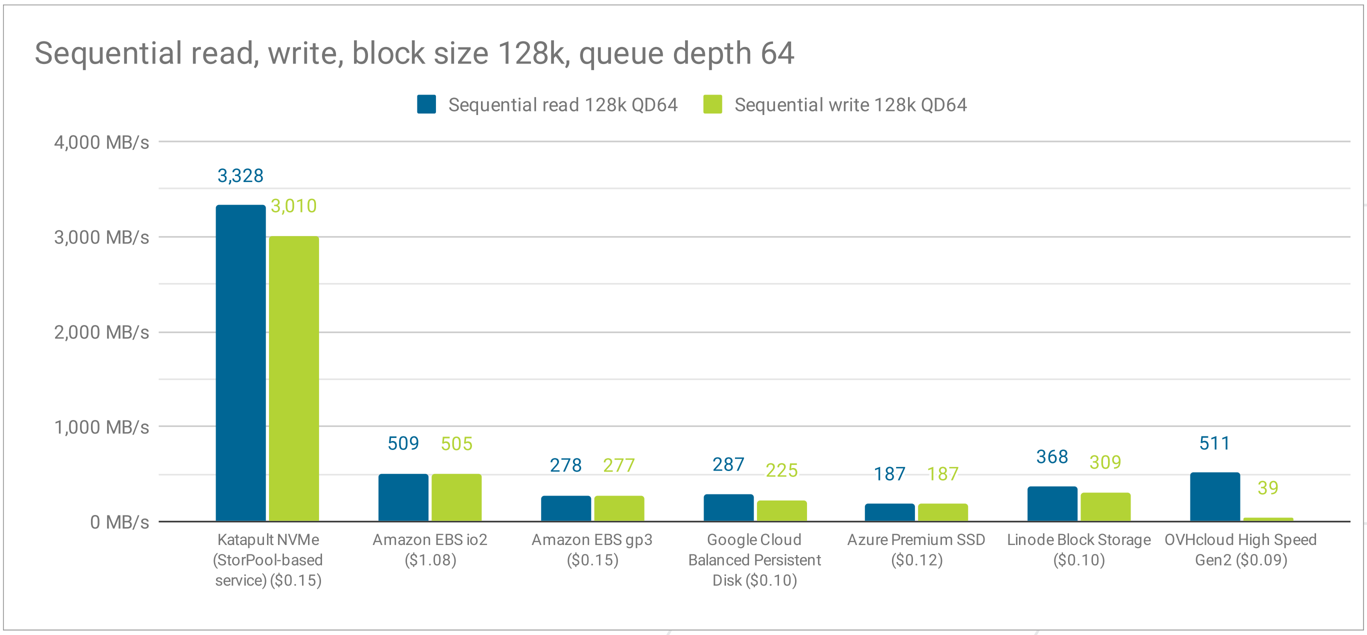
FIO IOPS

- Parallel random workload
- Random read/write 50/50 mix
- Block size 4k
- Queue depth 64



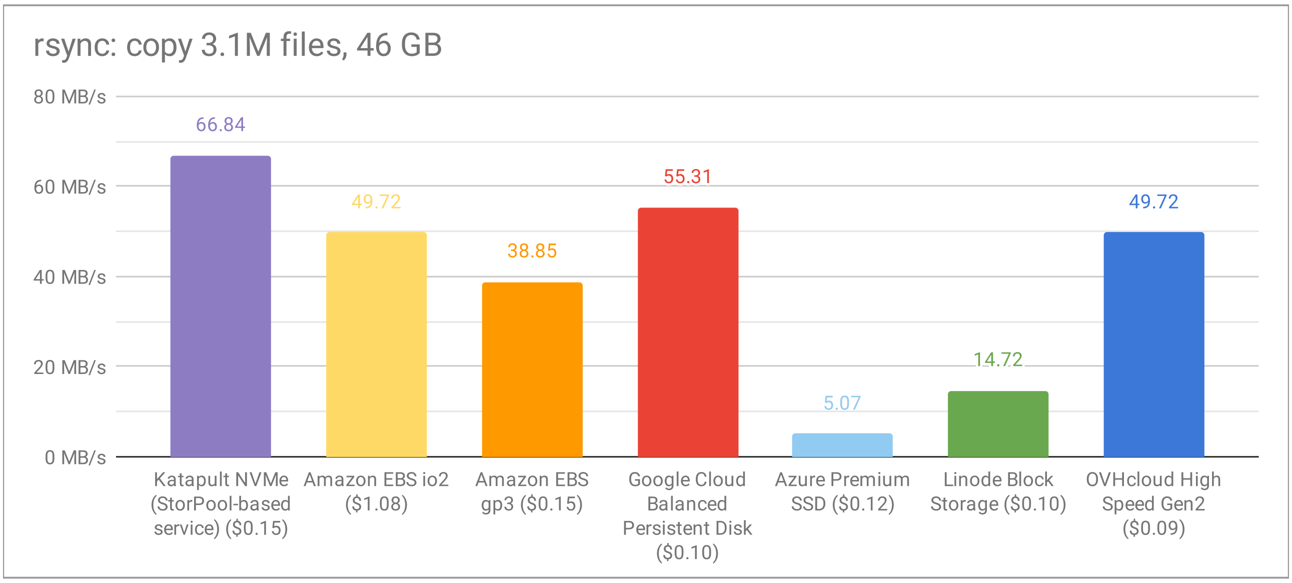
FIO MB/s

- Streaming workload
- Sequential read; Sequential write
- Block size 128k
- Queue depth 64



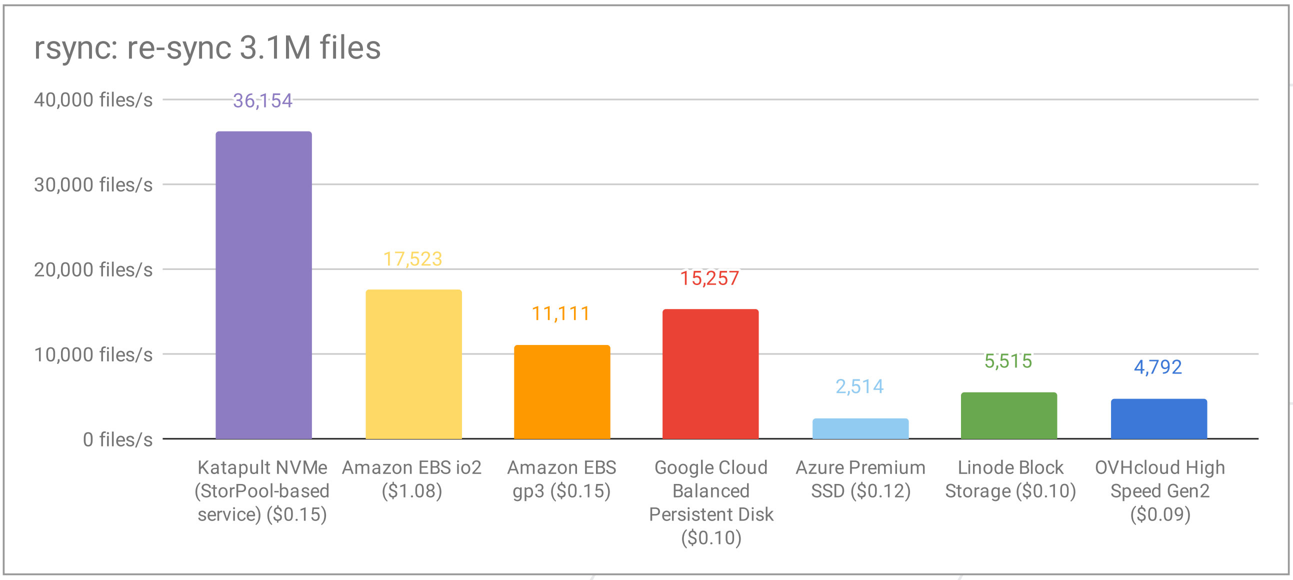
RSYNC copy

- ext4 filesystem
- Linux kernel source (4.17.13) times 50
- 3.12M files
- 46 GB data
- destination directory is empty
- clear cache, then copy files to destination directory
- **approximates deployment workload** – readdir(), sequential reads, sequential writes



RSYNC sync

- ext4 filesystem
- Linux kernel source (4.17.13) times 50
- 3.12M files
- 46 GB
- source and destination directories are identical. Each holding 3 million files.
- clear cache, then sync files to destination directory
- **approximates backup workload** – dominated by readdir() and stat()



Conclusions

Storage performance determines application performance to a large degree. VMs with seemingly identical parameters like CPU and memory can have orders of magnitude differences in application performance.

Both IOPS and latency are important for application performance.

End-user applications on StorPool-based public clouds perform measurably better (in some examples 2.5x better) than the second-best public cloud offering.

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About StorPool

StorPool is a software provider that develops the most reliable and speedy storage platform on the market. StorPool Storage is the easiest way to convert sets of commercial off-the-shelf servers into primary storage systems for cloud infrastructure. Public and private cloud builders - Managed Services Providers, Hosting Services Providers, Cloud Services Providers, enterprises, and SaaS vendors - use StorPool Storage as the foundation for their clouds.

StorPool Storage is designed for large-scale deployments, but it has efficient resource consumption and can start small. Each cluster scales seamlessly online - adding drives or servers expands both its capacity and performance. Adjusting StorPool volume capacity and performance also happens online without disrupting user workloads. Updates are also carried out online, without any interruptions to user-facing services.

The software comes as an utterly hands-off solution - the StorPool team architects, deploys, tunes, monitors, and maintains each StorPool Storage system so that end users experience speedy and reliable services.

StorPool Storage is a superior alternative to mid- and high-end SANs and All-Flash Arrays (AFA) for large-scale deployments (hundreds of terabytes to petabytes of storage).

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High Performance Linearly Scalable Primary Storage Platform

The ideal foundation for large-scale clouds running diverse, mission-critical workloads.

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