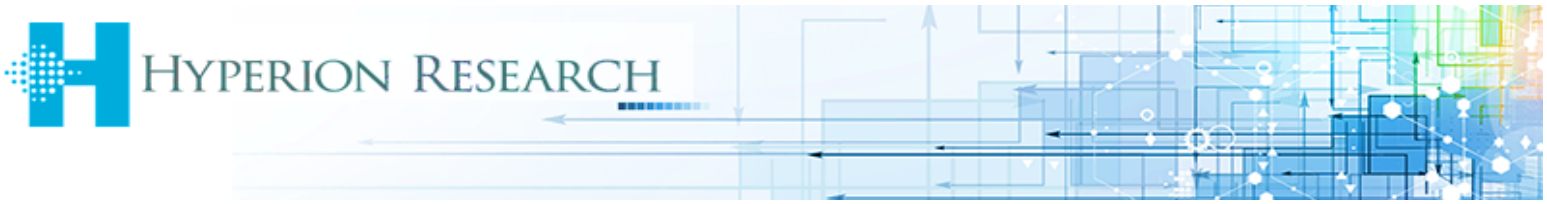

Technology Spotlight

HPC Storage TCO – Critical Factors Beyond $/GB

Sponsored by WekaIO

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HYPERION RESEARCH OPINION

This Technology Spotlight explores the critical purchase factors beyond cost when users evaluate different solutions. With limited annual budgets that may experience some modest increases each year, it stands to reason users keep the system's expense at the forefront of their mind throughout the RFI and RFP process. From the HPC storage perspective, the budget equation historically used is price-per-capacity ($/GB) as the principal cost metric. While a useful point of comparison when evaluating alternatives, $/GB fails to capture many other elements associated with installing, running, and maintaining a storage system.

Further complicating the total cost of ownership (TCO) analysis is the growing adoption of cloud for running HPC workloads. On-prem costs are straightforward, with some combination of up-front fixed costs, on-going fixed allocations, and personnel-driven variable costs. Cloud expenses, on the other hand, are a complex array of time-based and utilization-based expenses, some of which are not readily apparent.

Continuously increasing performance and capacity requirements, support for heterogenous traditional HPC modeling/simulation and HPDA/AI/ML/DL workloads, and differences between on-prem and cloud operational business models create a complex TCO calculus. As a result, it is more critical than ever for users to understand factors beyond just $/GB that contribute to a storage system's TCO.

This paper explores the various elements of the storage TCO equation. The experience of Genomics England is also shared, including their storage TCO analysis, the WekaIO-based solution chosen for their modern storage platform, and how they optimized their storage TCO.

SITUATION OVERVIEW

The Role of Storage in the Broader HPC Market

The HPC on-premises market consists of five broad market areas with total spending forecasted to exceed $40B in 2024. Storage is consistently the second largest area of HPC on-prem expense (after servers), representing approximately 20% of total HPC on-prem spending. Storage also exhibits the largest annual growth rate (8.5% CAGR). See Table 1.

TABLE 1

Revenues by the Broader HPC Market Areas ($M)

	2019	2020	2021	2022	2023	2024	CAGR '19-'24
Server	$13,595	$13,744	$13,741	$16,197	$17,708	$18,977	6.9%
Storage	$5,379	$5,520	$5,605	$6,675	$7,478	$8,075	8.5%
Middleware	$1,599	$1,618	$1,640	$1,946	$2,142	$2,310	7.6%
Applications	$4,647	$4,682	$4,643	$5,380	$5,783	$6,092	5.6%
Service	$2,218	$2,186	$2,131	$2,421	$2,552	$2,636	3.5%
Total Revenue	$27,438	$27,750	$27,761	$32,619	$35,662	$38,090	6.8%

Source: Hyperion Research, May 2021

Users are increasingly running more of their workloads in the cloud, as well. Current HPC user spending to run HPC workloads in the cloud is approximately $4B and is forecasted to grow to $8.8B in 2024. With Hyperion Research's recent studies concluding roughly one-third of HPC spending in the cloud is on storage, annual cloud storage spend is forecasted to be almost $3B by 2024. See Table 2.

TABLE 2

HPC Cloud Spend ($M)

	2019	2020	2021	2022	2023	2024
Total Cloud Spend	$3,910	$4,300	$5,300	$6,400	$7,600	$8,800
HPC Cloud Storage Spend	$1,303	$1,529	$1,793	$2,104	$2,467	$2,894

Note: These figures represent the amount of money users spend to run their workloads in the cloud.

Source: Hyperion Research, March 2021

HPC Storage System TCO Elements

There are multiple ways to characterize the range of cost factors to consider for a storage system's TCO. An approach that Hyperion Research often uses includes product, people, operations, and productivity.

- Product cost includes up-front fixed costs and annual variable licenses for the elements of a storage solution required to store and protect the data. These requirements may vary by datacenter, as might their respective costs. For example, some common considerations are:
  - On-prem storage hardware: storage enclosure, HDDs, SSDs, switches, cables, power cords, etc.
  - On-prem storage software: file system licenses, storage management tools, etc.
  - On-prem storage system support and maintenance contracts
  - Cloud storage: storage instance or capacity, dependent on if temporal or durable storage
  - Cloud data transfer: dependent upon the particular cloud services provider (CSP) and type of job and can include ingress, internal cloud transfers, and egress
- People cost refers to the HPC datacenter's personnel who manage the storage system. Functions can include storage administration, storage installation, system tuning and optimization, and facilities personnel. Depending on the size of the datacenter and the capacity of the storage system, the personnel may be dedicated to storage or share managing all aspects of the HPC system.
  - A recent Hyperion Research TCO study showed that roughly 43% of the sites surveyed employed three or fewer dedicated storage personnel and only 10% employed more than five.
  - It should be noted the sites of the TCO survey had a relatively uniform distribution of storage capacity, with 14% of sites having high storage capacities of more than 50 PB, 14% low capacities less than 0.1 PB, and the largest percentage (20%) between 2 and 10 PB. Intuitively it would seem that higher storage capacity should necessitate more storage personnel; interestingly, this correlation was not exhibited.
- Operations cost refers to the physical datacenter, including floor space allocations, power, and cooling. One factor complicating consideration of operations cost is the different ways organizations account for them. One model has them directly charged to the HPC datacenter while another model has them covered by a corporate-wide facilities expense.
  - The accounting method for the operations cost should be clearly stated and communicated as part of the TCO analysis.
- Productivity is probably the most elusive and least-often considered TCO cost element and includes time lost due to non-optimal storage system operation. Items to consider relative to productivity include:
  - Frequency and duration of system tuning
  - Frequency and duration of system failure
  - Researchers' time and delays to scientific discovery

On-Prem Versus Cloud Storage Metrics

Achieving an equivalent cost comparison between on-prem storage expense and cloud storage expense is difficult, at best. TCO metrics vary depending on the overall datacenter management and governance, the type of work being performed, and the type of business the datacenter supports. Table 3 summarizes a Hyperion Research qualitative framework of metrics for a comparative on-prem vs. cloud storage TCO analysis. Implicit in this analysis is the notion of CAPEX vs. OPEX. Optimizing for one or the other is inherently neither good nor bad and depends strictly on the business model of the organization. What is critical is a comprehensive understanding of both CAPEX and OPEX to achieve a credible, high quality comparison.

TABLE 3

Storage TCO Metrics

Metric	On-prem	Cloud	Notes
Capital expense	$	n/a	Includes up-front cost of on-prem storage system
Capacity	$/GB	$/GB $/GB/month	Dependent on mix of HDDs & SSDs required to achieve balance between capacity and performance Cloud dependent on whether storage is temporal or durable
Performance	$ per GB/s $/IOP Job queue time Job completion time	$ per GB/s $/IOP Job queue time Job completion time Premium networking	Several HPC cloud solutions offer different networking options to support different performance requirements. This often applies to the storage network in addition to the system network.
Power	$ per KW hour	n/a	
Datacenter personnel	$ per individual per time period	$ per individual per time period	Cloud can be less if headcount can be reduced by moving from on-prem to cloud
Research personnel	$/hour of waiting for on-prem system		Related to on-prem job queue and completion times, this is a leading driver for users moving certain workloads to the cloud
Lost business	$ revenue loss due to system unavailability and downtime	$ revenue loss due to system unavailability and downtime	Causes of downtime differ between on-prem & cloud. Probabilities of the different types should be factored into the analysis.

Source: Hyperion Research, March 2021

A Real-World Example: Genomics England

Genomics England (GEL) shared their experience with a successful storage TCO analysis. Founded in 2013, GEL has a mission of moving toward a future of enabling faster, deeper genomic research, bringing genomic healthcare to all who need it. Under the directive of the UK's National Health Service (NHS), GEL was established to deliver the 100,000 Genomes Project, an effort with an initial goal to sequence 100,000 whole genomes from NHS patients with rare diseases, and their families, as well as patients with common cancers. Supporting 3,000 researchers from academia and pharmaceuticals with 80% located in the UK while also expanding their target of sequenced genomes from 100,000 to 5,000,000, GEL has some very challenging HPC computing and storage requirements.

Prior to GEL's HPC storage upgrade, their storage infrastructure consisted of 20PB of file storage from a leading HPC storage vendor at a single site. Rather than providing direct GEL personnel to staff an HPC datacenter, they employed a managed service provider to manage their infrastructure. With their existing storage infrastructure approaching capacity, GEL embarked on a comprehensive RFQ process. Having initially requested RFQs from five vendors, the final analysis compared 3 options:

- Expanding their existing on-prem solution
- Implementing a WekaIO-led on-prem solution (in conjunction with an object-based storage hardware partner)
- Utilizing a leading CSP's cloud storage solution

GEL's Storage Requirements

Due to the rapid expansion of the associated project, GEL needed a storage system that could handle the exponential influx of collected data they were expecting. This was their primary consideration since the productivity cost of not having storage available when needed would be extremely high. The data also needed to be live and available all the time, so cold storage was not a feasible option. Since this was a UK project, there was also sensitivity to data sovereignty and data access from outside of the country. Enhancing disaster recovery (DR) capabilities was also a key consideration.

Personnel costs are somewhat mitigated by GEL utilizing a managed services provider (MSP) to manage and maintain the GEL-owned infrastructure. As the MSP model is being employed with both the old system and the new system, this is a consistent comparison.

GEL's Solution and Results

Upon completing a thorough TCO analysis incorporating these key elements: product, people, and operations, GEL selected the WekaIO-led on-prem solution consisting of 2PB of flash storage on a primary site and 60PB of object storage spread across a primary site and two DR sites.

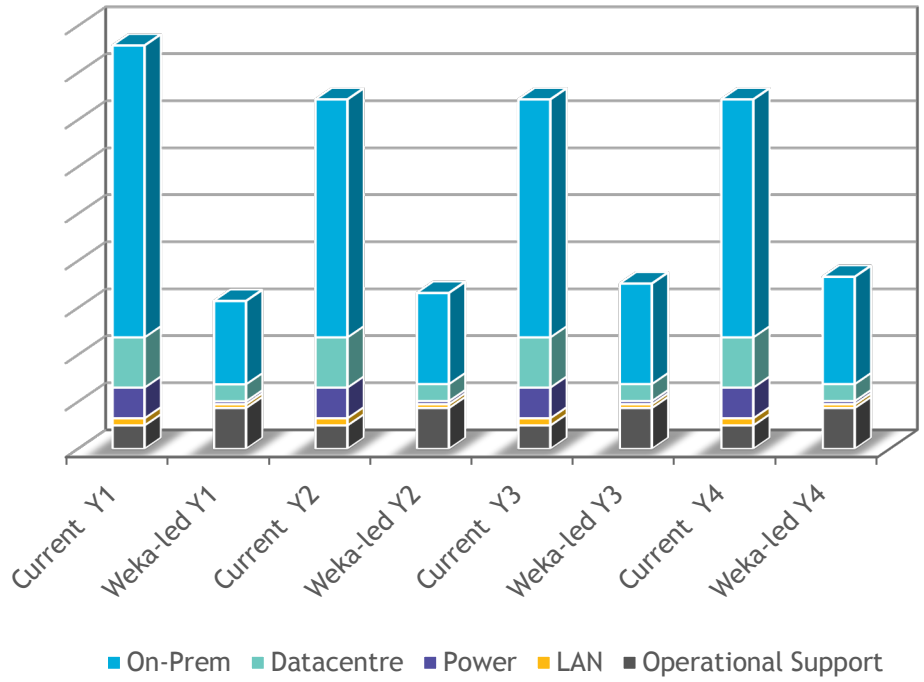
The results GEL reports are impressive:

- 62PB of combined flash and object storage that was less expensive than equivalent file storage and cloud storage
- 10x-15x job improvement performance
- 88% reduction in maintenance and support costs
- Positive TCO in 1.5 years

Figure 1 details GEL's storage TCO analysis comparing the WekaIO-led solution (the WekaIO file system software, the NVMe flash server hardware, and the object storage) with GEL's current NAS-based storage solution over the first four years of the 10-year analysis timeframe.

FIGURE 1

GEL Storage TCO Comparison



Note: y-axis starts at $0 and is on a linear scale.

Source: Hyperion Research, 2021

GEL found that the system exceeded the goals set forth for the requirements it was designed for. David Ardley, Director of Infrastructure Transformation shared, "We needed something that's much more scalable than existing NAS solutions – an infrastructure that could grow to hundreds of petabytes. Our existing solution couldn't provide that scale and wasn't performing as well in these magnitudes – that's what drove us to Weka".

WekaIO's Contribution

From the product perspective, the WekaFS file system is a key element that enabled the TCO results, GEL reported. Tightly integrating WekaFS with its compute, storage hardware, and networking partners afforded WekaIO the opportunity to deliver an optimized turnkey combined flash and object-based storage solution to meet GEL's demanding requirements in a cost-effective fashion. The performance of the file system, the scale supported by the unified namespace, and the simplicity of its

operation and maintenance allowed GEL's genomic sequencing application to realize the resulting improvements across all the TCO metrics.

The full productivity cost improvements can't be calculated and compared until the WekaIO-led solution has been operational over a period of time. However, GEL expects productivity cost improvements from the WekaIO-led solution as a result of its focus on simplified configuration and projected modeled fewer downtimes relative to failures and optimizations required.

GEL's TCO model projects substantial people maintenance and support savings as a result of the simplicity of configuration and management of the WekaIO-led flash and object-based solution compared to the existing NAS-based solution.

FUTURE OUTLOOK

Establishing a TCO framework clearly sets out what categories of costs should be considered, but assessing each respective cost is still challenging. Simple, historical metrics such as $/GB are necessary but not sufficient to fully appreciate all costs associated with buying running, maintaining, and supporting an HPC storage system. Time is the most complicated, yet arguably the most critical, factor in a TCO analysis: time to install, time to start computing, time to results, and downtime when the system is degraded or requiring service.

TCO will continue to be a primary yardstick which users employ to evaluate and compare solutions under consideration for purchase. Vendors who can clearly provide compelling evidence of how their part of the system contributes to the lowest TCO of the solution should find themselves worthy of top consideration in a majority of competitive bids. WekaIO's focus on speed, simplicity, and scale should position them well in situations where TCO is a primary user decision criterion.

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). Hyperion Research provides thought leadership and practical guidance for users, vendors and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

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