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Hitachi and Samsung confirm the benefits of using high-capacity SSDs and storage systems with the latest technologies.

WHITE PAPER

Hitachi Storage with High-Capacity SSDs

Verification of Hitachi Storage Systems with High-Capacity 30-TB SSDs

By Hitachi Vantara

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Contents

Notices and Disclaimer

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About This Guide

Intended Audience

This document is intended for Hitachi Vantara and Hitachi Partner representatives who need a foundation of knowledge on this subject to best represent it to potential consumers.

Document Revisions

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Executive Summary

High-capacity SSDs of 30 TB or more received the following evaluations upon their release to market and continue to receive similar evaluations even now:

> *"High capacity SSDs (over 16 TB) may be basically used for enterprise systems at Data Centers, but the cost is high and not for general-purpose use, even in the medium to long term. These drives will be used only for high-speed and large-scale purposes, such as image processing.*
>
> *Their price premium is prohibitive. It is forecasted that high-capacity SSDs will be less than a few percent of all SSD shipments in 2023 and their price premium will remain until then."*
>
> *"If the bit cost of high-capacity SSDs is attractive, we want to consider their adoption. But we are worried that super-high-capacity rebuild times would be measured in many more hours."*

Storage systems and SSDs continue to undergo innovations that further improve and increase not only capacity but also performance, reliability, and other key metrics.

The innovations made by Hitachi not only circumvent the issues cited above but also increase value and lower TCO when these high-capacity drives are used, as is shown in this paper.

Introduction

It is said that solid-state drives (SSDs) provide high performance while hard disk drives (HDDs) provide high capacity. To remain competitive and succeed in digital transformation, companies must be able to utilize larger and larger quantities of data at ever higher speeds. To address these requirements, SSD capacities have been increasing and SSD performance has also been steadily improving.

In this white paper, we confirm the following benefits of a storage system that uses high-capacity SSDs and SSDs equipped with the latest technologies:

- Performance
- Reliability
- Total Cost of Ownership (TCO)

We assume use cases for a small- to medium-size data analysis platform and replacement from a previous storage system to a new storage system with less than 1 PB total capacity. We made the following comparisons:

- Comparison of [lower-capacity SSDs (15 TB or less)] with [high-capacity SSDs]
- Comparison of [traditional storage system using lower-capacity SSDs] with [latest storage system using high-capacity SSDs]

Verification Results

From the perspectives of performance, reliability, and TCO, we compare and verify a Hitachi Enterprise storage system using [30-TB-class high-capacity SSDs] and [current mainstream SSDs (7.6 TB/15 TB)].

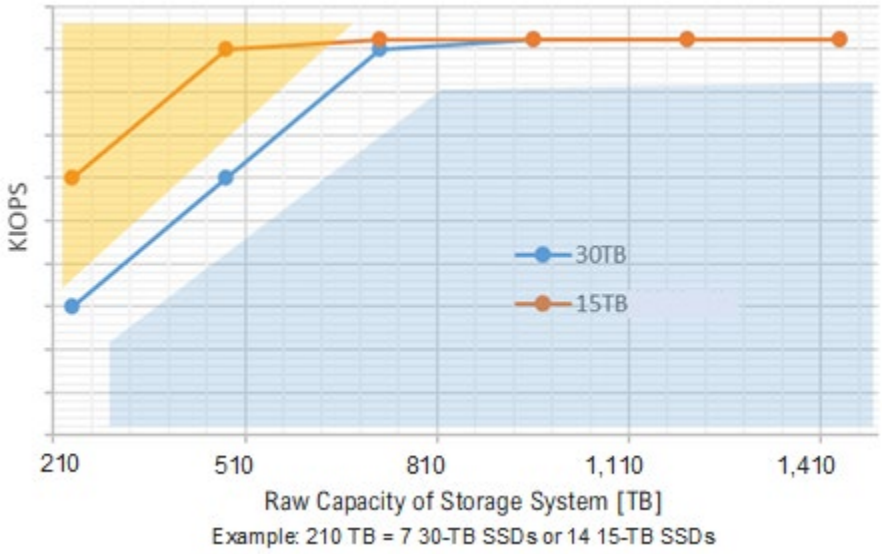
Performance

When HDDs were the primary type of storage media, the drives were often the bottleneck of storage performance, and performance bottlenecks could be avoided by using a large number of smaller drives in parallel or by using faster drives such as SSDs for cache memory.

In today's all-flash arrays (AFAs), however, the drives are usually not the performance bottleneck. In most cases, resources other than the drives, such as the CPU, server connection interfaces, and drive connection interfaces, become the bottleneck.

We therefore addressed the following question: What capacity SSDs should be installed to bring out the full performance of the storage system? The following graph (see Figure 1) shows the performance measurement results for a Hitachi Enterprise storage system using 15-TB SSDs and 30-TB SSDs.

Figure 1. Performance Measurement Results with 15-TB SSDs and 30-TB SSDs



The orange line shows the performance measurement results for the 15-TB SSDs. The horizontal axis is the capacity (TB), and the vertical axis is random access performance (KIOPS). As shown, the storage system has almost reached maximum performance when the total raw capacity is about 480 TB (32 drives).

The blue line shows the performance measurement results for the 30-TB SSDs. The storage system reaches maximum performance when the total raw capacity is about 720 TB (24 drives). This indicates that resources other than the SSD drives are causing a bottleneck when more than 24 drives are installed.

In this case, when the storage system capacity is 720 TB or more, there is no difference in maximum performance between the 15-TB and 30-TB SSDs. At the same time, when you choose 30-TB SSDs instead of 15-TB drives, the number of drives is cut in half, so you can reduce the number of drive chassis and expect benefits in terms of equipment initial cost.

However, when high-capacity SSDs are used to reduce total storage system cost, does the increased SSD capacity affect storage system reliability?

Next, we compare and verify storage system reliability.

Reliability

Rebuild Time in Case of Drive Failure (time required for recovery)

When a drive failure occurs during normal operations, the storage system recovers by using the data on the remaining drives in the same RAID group to reconstruct the missing data. This process is called the *rebuild*, and the time to complete the rebuild is called the *rebuild time*. When high-capacity drives are used, the rebuild time can be a concern because larger drives need longer rebuild times.

Historically, the rebuild process was designed to minimize the risk of performance impact to user data access, and the process design assumed HDD performance but not SSD. Now with updated technologies, Hitachi's latest storage systems demonstrate a huge improvement in drive rebuild times due to the parallelized rebuild process for SSDs. Rebuild times on these Hitachi storage systems have been reduced by up to 80% compared with previous models (see Figure 2).

Figure 2. Efforts to Reduce Rebuild Time

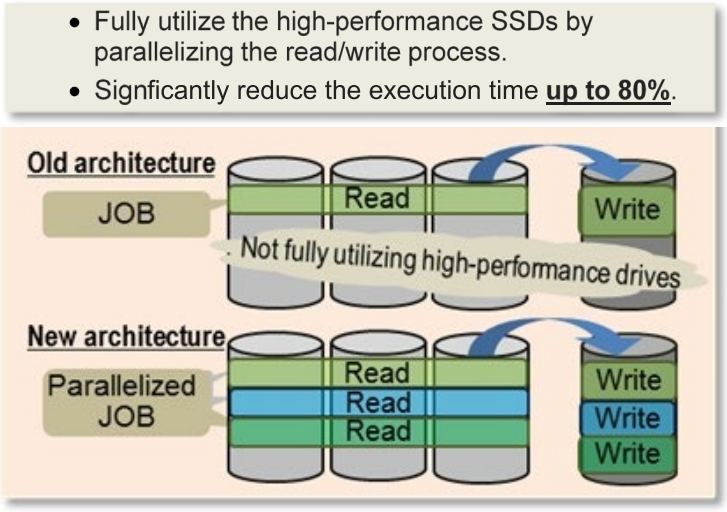
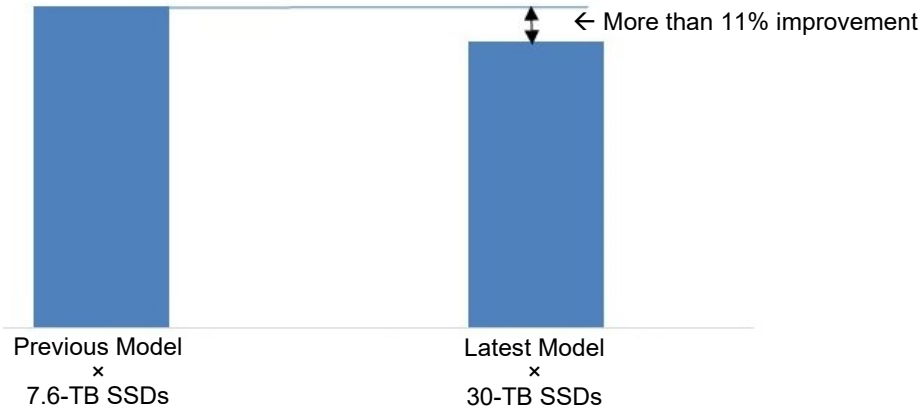


Figure 3 shows a comparison of [rebuild times for low-capacity SSDs (7.6 TB) on a previous generation model] with [rebuild times for high-capacity SSDs (30 TB) on a current model] (without I/O). As shown, we confirmed that even when the current model uses high-capacity 30-TB SSDs, the rebuild times are comparable to the rebuild times for the same model with low-capacity SSDs. In fact, rebuild times are shortened by 11% or more.

Figure 3. Comparison of Rebuild Times



So far, we have verified the performance and reliability of using high-capacity SSDs in Hitachi storage models. Next we verify the TCO.

Total Cost of Ownership (TCO)

We measured and verified TCO based on the following costs:

- Drive cost
- Equipment initial cost
- Power consumption
- Footprint
- Maintenance and operation management costs

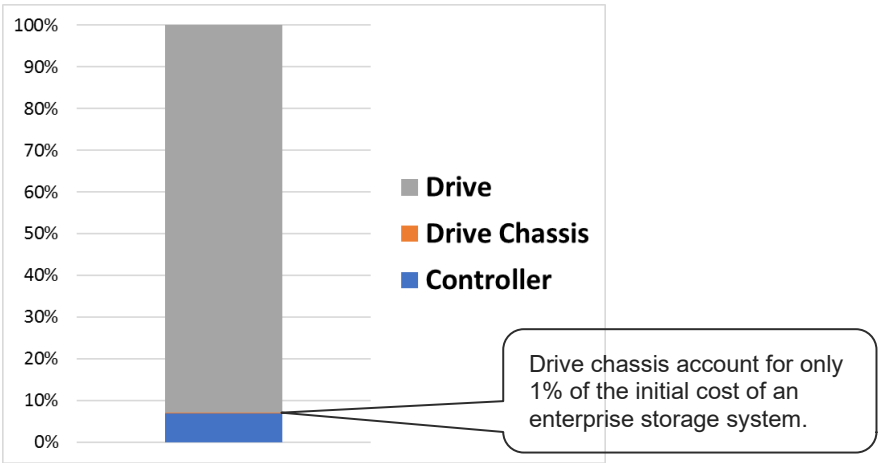
Drive Cost

The drive cost is a bit unit price equivalent to lower-capacity SSDs and is not a premium price. Please contact us for details.

Equipment Initial Cost

The following figure shows the equipment initial cost image. As shown, the drives account for most of the initial cost, so we cannot expect much cost reduction other than the drive cost. On the other hand, the drive cost will become appropriate with further market penetration, so selecting the appropriate drives according to requirements is an important factor in reducing the equipment initial cost.

Figure 4. Equipment Initial Cost Image



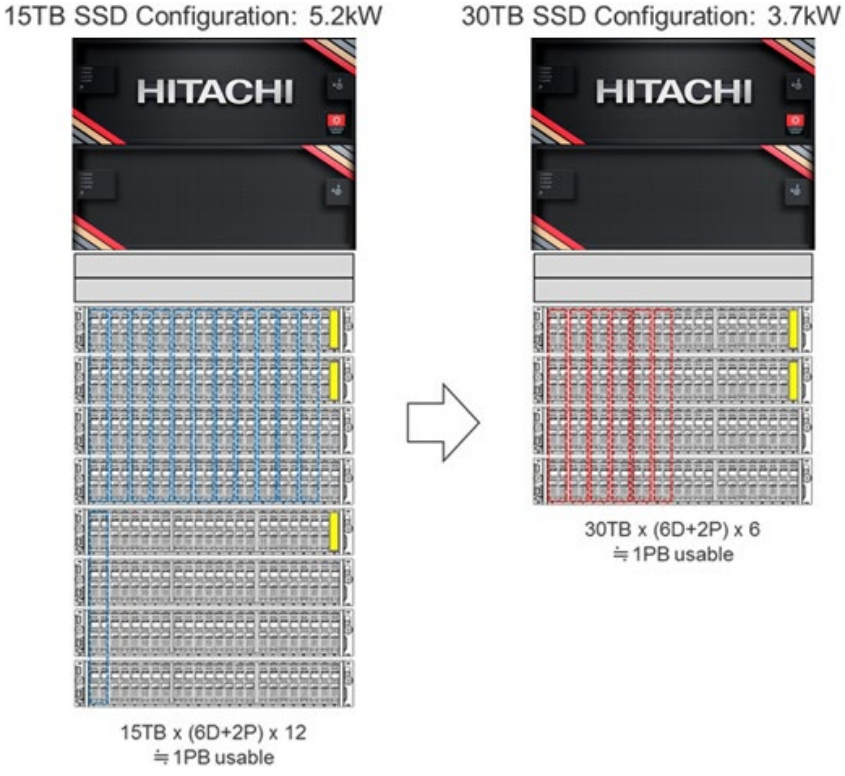
It must be said that the latest high-capacity 30-TB drives currently have little cost reduction effect in terms of equipment initial cost. However, 30-TB SSDs have other cost reduction effects that can result in significant savings.

Next we verify costs other than equipment initial cost.

Power Consumption and Footprint

The following figure compares the 15-TB SSD configuration and the 30-TB SSD configuration on a Hitachi Virtual Storage Platform 5500 (VSP 5500) storage system with an effective total capacity of 1 PB.

Figure 5. Comparison of 15-TB SSDs with 30-TB SSDs on Hitachi VSP 5500



The power consumption of the Hitachi VSP 5500 was 5.2 kW for the 15-TB SSD configuration and 3.7 kW for the 30-TB SSD configuration. In a large storage system configuration in which the effective capacity exceeds 1 PB, power savings of 1.5 kW can be realized by using 30-TB SSDs instead of 15-TB SSDs. In addition, the footprint is also reduced by decreasing the number of drive chassis from two to one.

Maintenance Costs due to System Component Failure

The following table shows the total number of system components in the 15-TB SSD configuration and the 30-TB SSD configuration of the storage system shown above in Figure 5. As shown in the table, the total number of components is reduced by 30% in the 30-TB configuration, which means the failure rate is also expected to decrease. In the verification, the 30% reduction effect was confirmed.

Table 1. Total Number of System Components

	15-TB SSD Configuration	30-TB SSD Configuration
Total number of system components	116	59
		Reduction effect: 30.3%

Maintenance and Operation Management Costs

As shown above, using 30-TB drives makes it possible to provide a large amount of capacity within one storage system, enabling you to consolidate multiple storage systems into a smaller number of high-capacity storage systems. When the total number of managed storage systems is reduced, the maintenance and operation management costs (including system monitoring, configuration changes, field engineering, support engineering, and so on) are also reduced.

According to marketing research company survey results, maintenance and operation management costs account for about 30% of the annual IT budget of companies. The annual IT budget for about 80% of large companies is 100 million yen or more, and 10% of those companies have an annual IT budget of 50 billion yen or more, so significant cost reduction effects can be expected.

Overview of Products

The following products were used in our comparison testing and verifications:

- Hitachi Virtual Storage Platform 5000 Series
- Samsung PM1643a SAS 30-TB SSD

Hitachi Virtual Storage Platform 5000 Series

Hitachi Virtual Storage Platform 5000 series (VSP 5000 series) storage systems are high-performance, large-capacity, enterprise RAID storage systems that accommodate scalability to meet a wide range of capacity and performance requirements. VSP 5000 series features all-flash and hybrid models that can scale up in capacity and also scale out for performance, allowing for massive consolidation of workloads and providing exceptional performance and efficiency.

Key features

- **Agility and scalability**

  The VSP 5100 and VSP 5200 all-flash arrays (AFAs) are scale-up enterprise storage platforms with one pair of controller nodes supporting open and mainframe workloads. VSP 5500 and VSP 5600 AFAs start with a single node pair and can scale out to three node pairs. All of these models are also available as hybrid arrays (VSP 5100H, VSP 5200H, VSP 5500H, VSP 5600H) that support the following drives: NVMe SCM, NVMe SSD, SAS SSD, SAS FMD (with upgrade to VSP 5600), and SAS HDD.

- **All-flash performance accelerated by NVMe technology**

  NVMe drives provide high throughput and low latency to achieve high response performance, enabling large volumes of data to be processed rapidly with response times as low as 39 microseconds. NVMe storage class memory (SCM) drives provide significantly quicker access to data, up to 10 times faster than flash drives, and are more durable than flash drives.

- **Capacity efficiency**

  The advanced adaptive data reduction (ADR) technologies of VSP 5000 series provide a guaranteed effective capacity of 4:1 to improve storage utilization and reduce storage footprint. Compression and also deduplication, if desired, can be enabled for all internal and external storage media at the volume level for enhanced tunability.

- **Reliability and resiliency**

  Leveraging hot-swappable components, nondisruptive maintenance and upgrades, and outstanding data protection, VSP 5000 series offers complete system redundancy and is backed by a 100% data availability guarantee. The active-active controller architecture of VSP 5000 series protects against local faults and performance issues, and hardware redundancy eliminates all active single points of failure, no matter how unlikely, to provide the highest level of reliability and data availability.

- **Data-in-place migration**

  Nondisruptive data-in-place (DIP) migration is provided when upgrading from VSP 5100 to VSP 5600 or from VSP 5500 to VSP 5600.

- **Artificial-intelligence-based solutions**

  All VSP 5000 series models come with Hitachi Ops Center Analyzer, which analyzes telemetry to optimize application performance and prevent extended outages. Manual administrative tasks are streamlined and implemented with fewer errors, facilitating the addition of new applications and the expansion of existing applications. In addition, Hitachi Ops Center Analyzer works with Hitachi Ops Center Automator to maintain best practices and quality of service (QoS).

- **Simple, easy-to-use management**

  VSP 5000 series can be set up quickly and managed with ease using Hitachi Ops Center Administrator. Ops Center Administrator reduces the complexity of steps needed to deploy, monitor, and reconfigure storage resources. In addition, REST APIs allow integration with existing toolsets and automation templates to further consolidate management tasks.

  Hitachi Ops Center Suite delivers enhanced AIOps capabilities using AI/ML to provide real-time monitoring and to increase performance and tuning of your storage environment.

- **Protection from unauthorized access**

  All VSP 5000 series models are hardened to prevent any leaks of physical data as well as unauthorized system access, enabling you to protect sensitive data from unauthorized access, meet stringent data privacy requirements, and adhere to strict regulatory compliance policies. Additional measures are available to ensure quick recovery from ransomware attacks.

For additional information about the VSP 5000 series storage systems, please visit the Hitachi VSP 5000 series site: https://www.hitachivantara.com/en-us/products/storage/flash-storage/enterprise/vsp-5000-series.html

Specifications

Please visit Hitachi Vantara online to view the specifications for VSP 5000 series: https://www.hitachivantara.com/en-us/pdfd/specifications/virtual-storage-platform-vsp-5200-5600-spec-table.pdf

Environmental sustainability

Hitachi's ambition is to become a climate change innovator by helping governments, cities, and companies to cut their carbon footprints and carry out climate change initiatives. Hitachi is uniquely positioned to combine information technology, operational expertise, and physical products to tackle climate change. Hitachi innovates in pursuit of long-term environmental improvements and is applying that same innovation to its own business to contribute to a Net Zero society.

Hitachi strives to achieve a more sustainable society in order to help resolve environmental issues. To underline its commitment to address climate change, Hitachi has strengthened its climate target to contribute to a Net Zero society by achieving carbon neutrality through its entire value chain by FY2050, including production, procurement, and the use of products and services. This bolsters Hitachi's existing commitment of reaching carbon neutrality at all its factories and offices globally by FY2030.

For additional information, please visit the Hitachi environmental sustainability site:
https://www.hitachi.com/environment/index.html

Samsung PM1643a SAS 30-TB SSD

Key features

- **High performance**

  With read/write performance more than 4 times higher than SATA drives, the PM1643a 12-GB SAS SSD provides a massive upgrade to the data transfer capabilities of the storage array.

- **High capacity**

  The PM1643a SAS SSD is available in a range of capacities, from 960 GB to an industry-leading 30.72 TB.

- **High availability**

  The PM1643a drive supports dual-port functionality to enable two access paths to the storage array controller. PM1643a delivers the reliability, availability, and serviceability (RAS) that is required for enterprise storage environments.

- **Data efficiency**

  Take control of your data efficiency with the capacity, performance, and accessibility of the PM1643a 12G SAS SSD.

Enterprise storage environments have unique requirements to ensure that they operate optimally 24/7, 365 days a year. Maintaining low latency and stability while addressing varying workloads is essential. Most crucial of all is protection from data corruption or loss due to unexpected power outages. Considering these factors, IT and data center managers are tasked with finding high-performing and dependable memory solutions.

Samsung is offering enterprises superb solid-state drives (SSDs) that deliver outstanding performance in multi-thread applications, such as compute and virtualization, relational databases, and storage. These SSDs are also extraordinarily reliable for continuous operation regardless of unanticipated power loss.

Using proven expertise and a wealth of experience in cutting-edge SSD technology, Samsung memory solutions help data centers operate continuously at the highest performance levels. Samsung has the added advantage of being the sole manufacturer of all of its SSD components, ensuring end-to-end integration, remarkable quality assurance, and the utmost compatibility.

Specifications

The following table lists key specifications for the Samsung PM1643a SAS SSD.

Table 2. Samsung PM1643a Specifications

Item	Specification
Form factor	2.5 inches
Capacity	960 GB, 1.92 TB, 3.84 TB, 7.68 TB, 15.36 TB, 30.72 TB
Host interface	SAS 12 Gbps
Spec compliance	Compliant with SCSI Specification (SAS-3/SPL-3/ SBC-4/ SPC-5/ SAM-5)
NAND flash memory	Samsung V-NAND
Power consumption (active/idle)	12.5 W / 5.5 W
Uncorrectable bit error rate (UBER)	1 sector per 10~17 bits read
Mean time between failure (MTBF)	2,000,000 hours
Endurance	1 DWPD for 5 years
Sequential read	Up to 2,100 MB/s
Sequential write	Up to 2,000 MB/s
Random read	Up to 450,000 IOPS
Random write	Up to 90,000 IOPS
Physical dimensions	70 x 100 x 15 (mm)

Conclusion

In this white paper, Hitachi and Samsung compared and verified key performance, reliability, and TCO metrics for a conventional storage system with conventional SSDs (7.6 TB, 15 TB) and a Hitachi Enterprise storage system (Hitachi VSP 5500) with the latest high-capacity SSDs (30-TB Samsung PM1643a).

Performance

For storage system capacities of 720 TB or more, there is no difference in maximum performance between 15-TB SSDs and 30-TB SSDs.

Reliability

Hitachi VSP family storage systems demonstrate improvement when fully utilizing high-performance SSDs with the parallelized read/write process. Rebuild time for drive replacement is reduced by up to 80% compared with traditional storage systems to achieve high reliability.

TCO

Using 30-TB SSDs instead of 15-TB SSDs cuts the number of drives in half, which reduces the number of drive chassis and decreases equipment initial cost. While this reduction of equipment initial cost is not large at this time, cost reductions due to the following other factors can provide more significant cost savings:

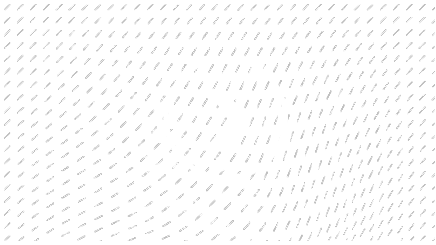
- Decreased power consumption
- Reduced footprint
- Decreased costs for fewer storage system components
- Decreased maintenance costs for fewer storage system components
- Reduced maintenance and operation management costs for fewer storage systems

Summary

Hitachi storage systems equipped with high-capacity SSDs achieve the same or better performance than storage systems with smaller drives. These Hitachi storage systems also deliver higher reliability by providing faster drive rebuild times and using fewer drives.

Use of high-capacity SSDs does not significantly increase costs. When compared by bit unit price, the drive price for high-capacity SSDs is almost the same as the drive price for lower-capacity SSDs. The TCO for the Hitachi storage system is in fact lower because of cost reductions in power consumption, maintenance, and operations.

As reported herein, we were able to confirm that customers can proceed confidently with their transition to current Hitachi Enterprise storage system models that support 30-TB-class high-capacity SSDs, including VSP 5000 series and VSP E series models.



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