



Total Cost of Ownership Study

The Economics of Running the SAP HANA[®] Platform in the Enterprise

Research by Prowess Consulting found that Lenovo[®] ThinkSystem[™] SR950 V3 servers provide a lower three-year total cost of ownership (TCO) than competing SAP HANA systems.

Executive Summary

Businesses rely on transactional and analytical databases for a single source of truth. Organizations of all sizes need to extract insights from these large databases, and housing the databases in memory can accelerate actionable insights, increasing business competitiveness. But in-memory processing requires massive amounts of DRAM. And while the price of memory continues to decline, single-unit scale-up servers and multi-node scale-out clusters still represent a sizable investment for IT organizations.

With its advanced in-memory technology, the SAP HANA® platform is widely used by organizations that need rapid processing for large volumes of data that is optimized for in-memory workloads. However, the price of acquisition is only part of the cost; SAP HANA deployments can be expensive to operate, particularly when labor costs for the specialists required to manage them are factored in.

To evaluate total system costs, Lenovo commissioned Prowess Consulting to assess scale-up systems in a variety of memory configurations for SAP HANA solutions running on servers powered by the latest-generation Intel® Xeon® Scalable processors from HPE and Lenovo. Our analysis shows that eight-socket Lenovo® ThinkSystem™ SR950 V3 servers running Red Hat® Enterprise Linux® for SAP® Solutions provide a lower total cost of ownership (TCO) over a three-year period, compared to eight-socket HPE® Compute Scale-up Server 3200 servers.¹

We found that this lower TCO stems from both lower capital expenditures (CapEx) and especially lower operating expenses (OpEx) for the Lenovo® servers. In addition to raw TCO advantages, the Lenovo solutions for SAP HANA that we evaluated in our study also feature faster times to load databases into memory and perform complex queries than their counterparts from HPE, while providing high levels of reliability. Moreover, at the time of this writing, the ThinkSystem SR950 V3 server, alone among the SAP HANA platform–certified servers we examined, also provides an option for a scale-out configuration, which can be valuable for analytical workloads, such as SAP S/4HANA® software.

On-Premises Versus Cloud Deployment Considerations

Lenovo® solutions for the SAP HANA® platform provide up to

31% lower
three-year TCO than HPE® solutions.¹

Technology Trends

Real-time analytics are a primary operational requirement for enterprises. In-memory database platforms like the SAP HANA platform are the bedrock for this requirement. These platforms can also act as transactional databases for business applications, including finance, human resources (HR), order-to-cash, inventory, and forecasting. Running large databases in memory—even databases that are several terabytes large—can keep storage latency from slowing down queries. Doing so provides faster, more actionable insights on a single source of truth for analytics and transactions, even as datasets grow increasingly large.

Many kinds of applications beyond traditional line-of-business (LOB) applications build on top of databases to benefit from the in-memory, columnar capabilities of SAP HANA. SAP S/4HANA software provides enterprise resource planning (ERP) capabilities with the real-time performance of SAP HANA. SAP® BW/4HANA is the SAP® Business Warehouse solution optimized for SAP HANA, and it provides simplified operations and improved performance for business-warehouse applications.

The hardware supporting SAP HANA is crucial to realizing the performance capabilities of the platform. Attempting to run SAP HANA on hardware that cannot utilize all of its capabilities can constrain overall performance. As one means of avoiding such mismatches between hardware and software, SAP certifies SAP HANA appliances produced by OEMs that successfully integrate with SAP solutions. In addition, SAP requires that SAP HANA appliances have a valid SAP HANA hardware certification at the time of purchase by customers in order to qualify for SAP support.

The alternative to appliance-based deployment is SAP HANA Tailored Datacenter Integration (TDI). SAP HANA TDI offers organizations greater flexibility for integrating SAP HANA into their data centers, such as:

- Right-sizing CPUs to meet business needs (as opposed to being a single large size for appliances)
- Using new types of storage, such as NVM Express® (NVMe®)

However, such custom-built SAP HANA solutions must still be assembled using SAP-certified components and deployed with the SAP HANA platform installed by an SAP-certified engineer.

On-Premises Versus Cloud Deployment Considerations

Whether to deploy the SAP HANA® platform in the cloud is a question that many organizations grapple with, and it has no one-size-fits-all answer. SAP HANA in the cloud might save some organizations money while proving more expensive for others.² Likewise, cloud-based SAP HANA

might provide higher security for some organizations while being untenable for others due to legal or regulatory requirements. This study assumes on-premises deployment of SAP HANA, and it does not consider the ramifications of TCO for deploying SAP HANA in the cloud.

Comparison Motivation and Overview

Because of the centrality of SAP HANA workloads to business, we wanted to explore the differences in three-year TCO when running SAP HANA on x86 servers from OEMs with large market shares in the SAP HANA sphere: Lenovo and HPE. To assess SAP HANA TCO, we examined eight-socket servers from these OEMs with the latest-generation Intel Xeon Scalable processors certified for SAP HANA appliance and TDI deployments for SAP S/4HANA transactional and SAP BW/4HANA analytical workloads (see Figure 1).³

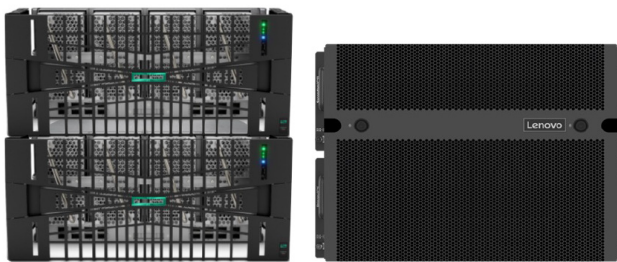


Figure 1. Eight-socket servers evaluated in this study from left to right: HPE® Compute Scale-up Server 3200 (left) and Lenovo® ThinkSystem™ SR950 V3 (right)

This study compares the CapEx to acquire systems that are certified for SAP HANA,⁴ in addition to the OpEx associated with running those solutions over a three-year period. At the time of publication, Lenovo is the only vendor to offer SAP HANA–certified scale-out systems. Therefore, this study only examines TCO considerations for SAP HANA systems in scale-up scenarios.

While this study primarily focuses on quantitative cost comparisons, we also examined other features of these systems that can aid business-critical SAP HANA workloads, such as the operating system. We evaluated both server systems running Red Hat Enterprise Linux for SAP Solutions and found that Red Hat Enterprise Linux for SAP Solutions provides critical uptime features, including Automation Focus in Red Hat Enterprise Linux, Red Hat Enterprise Linux System Roles for SAP, and Red Hat® Insights for SAP. These features can play a significant role in further reducing both planned and unplanned downtime.

TCO Findings

Our analysis found that ThinkSystem SR950 V3 servers cost \$756,428 less (per server) to acquire and operate over a three-year period than Compute Scale-up Server 3200 servers, for 31% lower TCO over three years (see Figure 2). For detailed pricing information, see [Appendix C: Three-Year Costs](#).

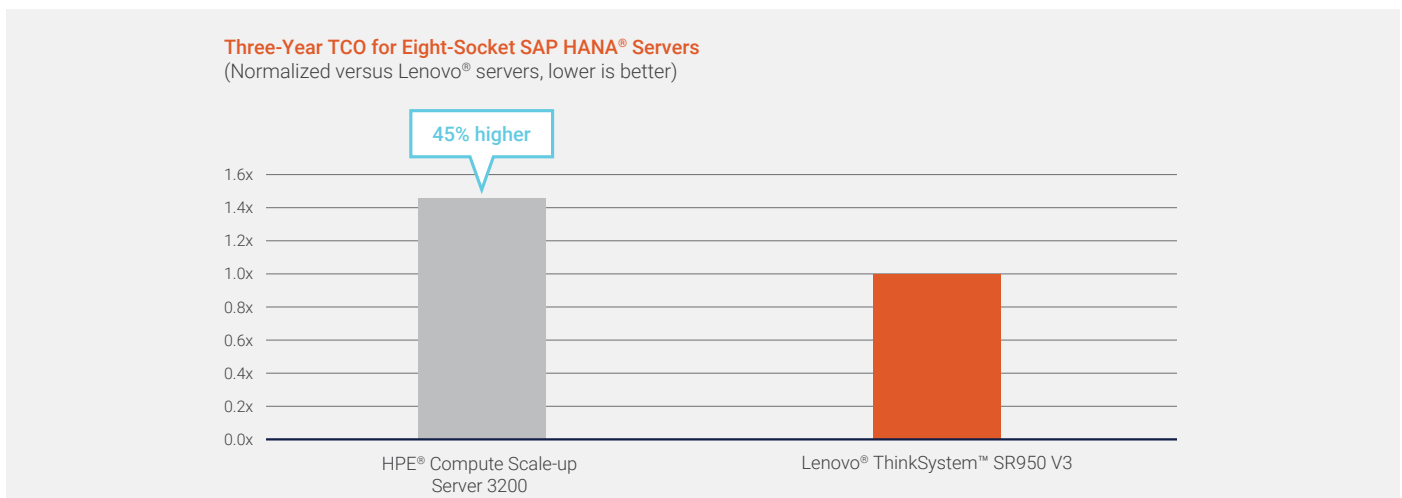


Figure 2. Among eight-socket SAP HANA® systems, Lenovo® ThinkSystem™ SR950 V3 servers provide a markedly lower TCO over a three-year period compared to HPE® Compute Scale-up Server 3200 servers

Study Methodology Details

The TCO examined in this study includes both CapEx and OpEx costs for selected SAP HANA appliances and TDI solutions from different OEMs. CapEx costs examined include:

- Server hardware
- Storage hardware (integrated)

OpEx can be more complex to assess. While power is unarguably an operating cost connected to a particular piece of hardware, other costs—like space in a data center—can be harder to isolate for individual solutions. For this reason, this study limits OpEx costs to the following:

- Management
- Power
- Cooling
- Downtime
- Labor

For specific assumptions about these costs, see [Appendix B: Study Assumptions and Methodology](#).

Downtime Costs

After CapEx costs and labor, downtime is the biggest contributor to three-year TCO for all of the servers we analyzed in this study. Based on the 2022 Information Technology Intelligence Consulting (ITIC) Server Reliability Poll,⁵ we estimated that server downtime costs Lenovo ThinkSystem server users \$16,500 on average over three years, compared to \$21,600 for HPE® servers (see Figure 3; see [Appendix B: Study Assumptions and Methodology](#) for details about our methodology).

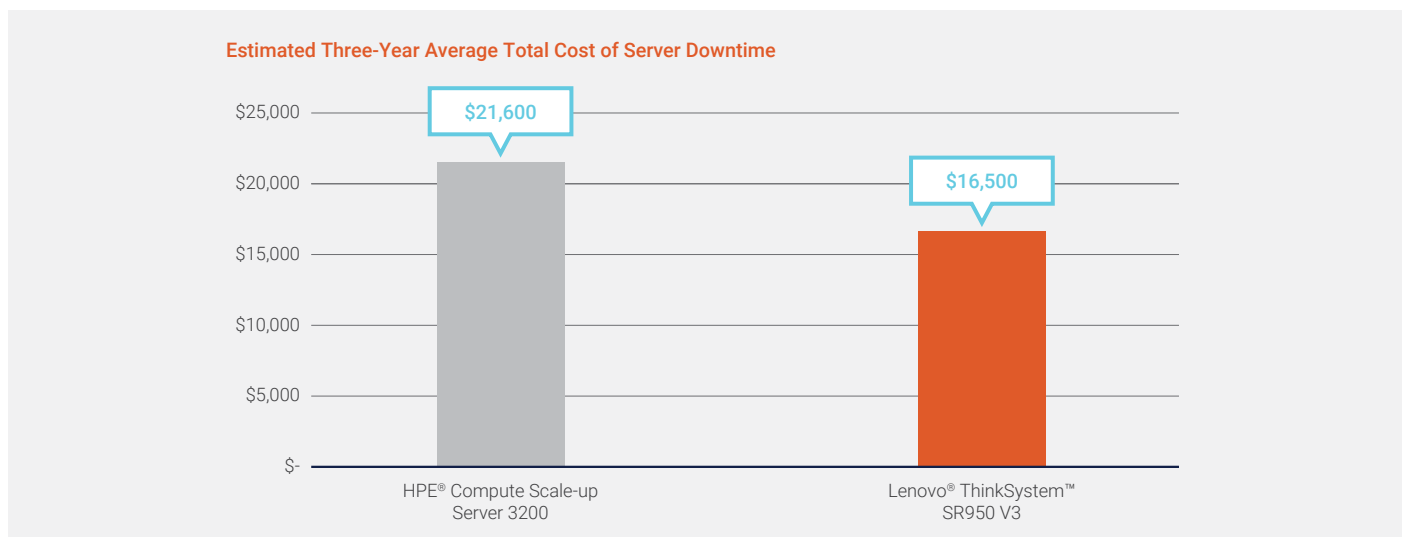


Figure 3. Server downtime is the third-biggest contributor to estimated three-year TCO for all servers examined, behind the cost of acquisition and management costs (see [Appendix B: Study Assumptions and Methodology](#) for details)

Shared Compute and Operating System (OS) Capabilities

While the servers we examined for this study possess many differences, they also share some capabilities stemming from the processors and operating systems on which they run.

Processor Capabilities

The 4th Gen Intel Xeon Scalable processors that power the servers examined in this study provide a number of benefits over the 2nd Gen Intel Xeon Scalable processors used in previous-generation eight-socket servers:

- 2.23x average performance improvement⁶
- Up to 1.60x higher input/output operations per second (IOPS) and up to 37% latency reduction for large-packet sequential reads using integrated Intel® Data Streaming Accelerator (Intel® DSA) versus the prior generation⁷
- Up to 95% fewer cores and 2x higher level-1 compression throughput using integrated Intel® QuickAssist Technology (Intel® QAT) versus the prior generation⁸

4th Gen Intel Xeon Scalable processors are designed to accelerate performance across the fastest-growing workloads in data analytics, networking, and storage.⁹ Examples of these accelerators include:

- Intel® In-Memory Analytics Accelerator (Intel® IAA), which improves analytics performance while offloading tasks from CPU cores to accelerate database query throughput and other workloads⁹
- Intel DSA, which drives high performance for storage, networking, and data-intensive workloads by improving streaming data movement and transformation operations⁹
- Intel® Advanced Vector Extensions 512 (Intel® AVX-512), which supports up to two fused-multiply add (FMA) units and includes optimizations to accelerate performance for demanding computational tasks⁹
- Intel QAT, which accelerates encryption, decryption, and data compression, offloading these tasks from the processor core to help reduce system resource consumption⁹

OS Capabilities

Red Hat Enterprise Linux for SAP Solutions is SAP's preferred operating system (OS) for SAP's own RISE with SAP offering. The Red Hat Enterprise Linux for SAP Solutions offering combines Red Hat Enterprise Linux with features and capabilities designed to support and simplify SAP workloads and operations.

Red Hat Enterprise Linux System Roles for SAP

Red Hat Enterprise Linux System Roles for SAP can be used to completely automate the deployment of a Red Hat Enterprise Linux system to run SAP workloads. This automation reduces the effort required to properly provision servers, apply all pre- and post-installation SAP® Notes, procure software installation kits from SAP® Marketplace, and cluster database and application tiers independently with full ENSA/ENSA2 support. Moreover, this automation enables administrators to deploy and operate SAP HANA across complex landscapes and with full product and non-product support accurately and quickly by using prebuilt and SAP-certified automation content.¹⁰

SAP-Specific Technical Components

Red Hat Enterprise Linux 8.6 for SAP Solutions includes SAP-specific technical components that support SAP S/4HANA, SAP HANA, and SAP® Business Application Studio. These components are designed to work seamlessly with SAP workloads and provide a stable and efficient environment for running SAP HANA applications.¹¹

High-Availability Solutions

Red Hat Enterprise Linux 8.6 for SAP Solutions offers SAP-certified, high-availability solutions for SAP S/4HANA, SAP HANA, and SAP Business Application Studio. These solutions provide reliability, scalability, and availability to critical production services and help ensure that SAP HANA applications remain available even in the event of a failure.¹¹

Red Hat's clustering technology for SAP software is fully application and database aware, and it supports all major modes of SAP HANA replication and failover, in addition to providing application tier failover and autoscaling, all as part of a Red Hat Enterprise Linux for SAP Solutions subscription.

Smart Management and Red Hat® Insights

Smart management and Red Hat® Insights tools provide lifecycle management and proactive optimization to help ensure SAP systems remain current with both OS patches and SAP best practices (SAP Notes), which can help to maintain the performance and efficiency of SAP HANA applications over time.¹¹

Update Services for SAP Solutions

Update Services for SAP Solutions provides support for specific minor Red Hat Enterprise Linux releases for four years from general availability. This helps ensure that SAP HANA applications remain up-to-date and secure.¹¹

In addition to Red Hat Enterprise Linux itself, Red Hat Enterprise Linux for SAP Solutions comes standard with:

- All additional packages necessary to install and run SAP
- Extended four-year update support
- An SAP-certified and integrated high-availability clustering solution
- Red Hat's award-winning SAP-aware smart-management technology, including Red Hat® Satellite and Red Hat Insights for SAP
- Red Hat Enterprise Linux System Roles for SAP, which fully automates the installation and post-install configuration and clustering of both SAP HANA and application servers

Qualitative Differentiators

Beyond the TCO benefits highlighted in this study, a number of hard-to-quantify differentiators emerged between the HPE and Lenovo SAP HANA solutions examined.

Space Efficiency and Total Memory

In order to scale up to eight Intel Xeon Platinum 8490H processors and 8 TB of memory, the Compute Scale-up Server 3200 system requires a 10U form factor versus the 8U form factor for the ThinkSystem SR950 V3 server for the same number of processors and the same amount of memory. This difference in form factors means that a typical 42U rack can hold four Compute Scale-up Server 3200 servers or five ThinkSystem SR950 V3 servers, a 20% gain in space efficiency for the ThinkSystem SR950 V3 server.

For total memory capacity, the ThinkSystem SR950 V3 server provides more options than the Compute Scale-up Server 3200 server. The ThinkSystem SR950 V3 server with eight processors can support up to 32 TB of DDR5 memory while the Compute Scale-up Server 3200 server with the same number of processors tops out at 16 TB of DDR5 memory, which can put more constraints on the types of critical workloads the HPE solution can run, compared to the Lenovo solution.

Reliability

While we quantitatively modeled reliability in the TCO figures, qualitative differentiators for reliability stood out from analyzing the SAP HANA solutions in this report. These differentiators can point to lower downtime and improvements for other sources of friction that might otherwise increase operational expenses.

Lenovo® Reliability, Availability, and Serviceability (RAS) Features

Lenovo servers continue to be the industry's most reliable x86 servers for the ninth year in a row, according to the "ITIC 2022 Global Server Hardware, Server OS Reliability Report" from ITIC.⁵ The report also noted that 92% of Lenovo users surveyed reported between 99.999% and 99.9999% uptime (less than 5 minutes and 16 seconds of annual downtime and 32 seconds of annual downtime, respectively). This figure exceeds the results reported by HPE users.⁵ Specific reliability, availability, and serviceability (RAS) features in the ThinkSystem SR950 V3 server include:

- **Predictive Failure Analysis (PFA)**, which alerts administrators to impending failure of processors, memory, power-supply units (PSUs), system fans, adapter slots, hard-disk drives (HDDs)/solid-state drives (SSDs), and voltage-regulator modules (VRMs). This feature allows servicers to schedule planned downtime, rather than reacting to sudden failures.
- **Independently powered light-path diagnostic LEDs**, which light up beside a failing component for instant identification in order to facilitate fast servicing and reduced downtime.

- **Machine-Check Architecture (MCA) recovery**, which provides OS-layer assisted recovery from uncorrectable data errors, helping prevent system resets.
- **Adaptive Double-Device Data Correction (DDDC)**, which protects the system from memory errors while repairing those errors.
- **Fatal-error handling**, which enables override of application shutdown by setting a custom handler of fatal errors.

Support, Management, and as-a-Service

Lenovo provides a range of management options for ThinkSystem servers running SAP HANA, like the ThinkSystem SR950 V3 server, so that administrators can focus on more strategic tasks. It also provides options to fully manage SAP HANA deployments and provide SAP HANA “as a service,” as described in the following sections.

Lenovo® Premier Support

Lenovo® Premier Support includes SAP HANA deployments. This dedicated support from Lenovo provides a single-point-of-contact support service, in addition to one-on-one access to the Lenovo Premier Support team of agents 24/7/365 via a dedicated phone number, online ticket, or live chat. It is also available at a variety of service levels. And because Lenovo also offers Premium support for Red Hat Enterprise Linux, it provides a single stop for both Red Hat Enterprise Linux and Lenovo support. For more information about Lenovo Premier Support, visit www.lenovo.com/us/en/premier-support/.

Lenovo® Managed Services for SAP HANA

With Lenovo® Managed Services for SAP HANA, Lenovo service professionals remotely monitor and manage supported server, storage, and networking devices, in addition to select third-party products sold by Lenovo or Lenovo-authorized resellers. These services can help enhance the security and reliability of data centers and help ensure high performance and stability for SAP HANA deployments. Continuous monitoring, scheduled health checks, and recommended updates can help control management costs for SAP HANA and provide skills and knowledge that IT organizations might not already possess. For more information about Lenovo Managed Services for SAP HANA, visit www.lenovo.com/us/en/resources/data-center-solutions/brochures/lenovo-managed-services-for-sap-hana/.

As-a-Service

Lenovo® TruScale® Infrastructure Services enables Lenovo customers to use SAP HANA as a service. This solution provides SAP HANA deployments with no upfront capital costs and a flexible, cloud-like consumption model with on-premises security and control, and it can be purchased with Red Hat Enterprise Linux. Lenovo TruScale Infrastructure Services is an all-inclusive offering that covers the full lifecycle of systems:

- Installation, deployment, and removal
- Comprehensive monitoring and proactive management
- Health checks and updates per customer schedule

Lenovo TruScale Infrastructure Services provides a dedicated customer-success manager, quarterly business reviews, support plans, and a customer portal. The solution can be integrated with the RISE with SAP solution, SAP S/4HANA Cloud, Private Edition, and customers’ data center options. For more information about Lenovo TruScale Infrastructure services, visit <https://techtoday.lenovo.com/us/en/solutions/iaas>.

Conclusion

Our analysis of the TCO for HPE and Lenovo offerings for SAP HANA reveals tangible three-year savings across the board with the Lenovo ThinkSystem SR950 V3 server running Red Hat Enterprise Linux for SAP Solutions, including a lower cost to acquire and operate compared to the HPE Compute Scale-up Server 3200 systems. In addition to quantitative differences between the solutions, the ThinkSystem SR950 V3 server provides qualitative benefits beyond those supplied by the competing HPE servers. Per ITIC, ThinkSystem servers continue to be rated among the most reliable servers in the industry,⁵ and the ThinkSystem SR950 V3 server hosts a number of unique RAS capabilities absent from the other system examined. Finally, our research notes that Lenovo services provide several means to simplify administering complex SAP HANA deployments, including Lenovo Managed Services for SAP HANA.

Appendix A: Hardware Specifications

Details for hardware specifications for each system examined in this study, grouped by OEM:

HPE

HPE® Compute Scale-up Server 3200	
Intel® Xeon® Platinum 8490H processor, 1.90 GHz, 60 cores, 350 W	8
64 GB (1 x 64 GB) quad-rank x4 DDR5-4800 CAS-46-39-39 EC8	128
HPE 480 GB Serial ATA (SATA) 6G mixed-use small form factor (SFF) BC multi-vendor SSD	2
HPE 7.68 TB Serial Attached SCSI (SAS) 24G read-intensive SFF BC multi-vendor SSD	6

Lenovo

Lenovo® ThinkSystem™ SR950 V3	
Intel® Xeon® Platinum 8490H processor, 1.90 GHz, 60 cores, 350 W	8
64 GB TruDDR5 4,800 MHz (2Rx4) 10 x 4 RDIMM	128
2.5-inch Micron® 5400 PRO 240 GB read-intensive SATA 6 Gb HS SSD	2
2.5-inch Samsung® PM1653 7.68 TB read-intensive SAS 24 Gb HS SSD	6

Appendix B: Study Assumptions and Methodology

This study makes the following assumptions in projecting the three-year TCO for the SAP HANA systems analyzed:

- **Capital costs**—This study uses the manufacturer’s suggested retail price (MSRP) for the servers examined and does not include any discounts that customers might receive in actuality.
- **Server utilization**—This study assumes 85% average power utilization by the servers examined.
- **Power costs**—This study uses the United States national average commercial cost of \$0.126 (in US dollars [USD]) per kWh.¹²
- **Cooling cost**—This study assumes that the heat dissipated by servers takes exactly its equivalent in amount of power to cool at 0.000293 kWh/British thermal unit (BTU).
- **Labor costs**—This study uses a uniform fully burdened cost of \$150,000 USD per year per full-time employee (FTE) equivalent for both storage and SAP HANA management.
- **FTE equivalents**—This study assumes 1.7 FTE equivalents per management responsibility for each server.

Downtime Costs—Estimate Details

In order to estimate downtime costs for this analysis, we drew upon the results of the 2022 ITIC Server Reliability Poll. Of respondents to the ITIC poll, 91% reported that a single hour of server downtime costs them \$301,000 or more, and 44% reported that unplanned server downtime costs them more than \$1 million.⁵ Based on these results, we used the more conservative figure of \$300,000 per hour of unplanned server downtime in this study (although the true figure is likely higher, as the ITIC survey polled organizations about the overall cost of their servers being down; downtime for the kinds of business-critical workloads that organizations run on SAP HANA is likely much more expensive). Table 1 lists the average annual downtime reported in the ITIC poll by server family and the resulting average annual cost of unplanned server downtime.

Table 1. Reported server downtime figures for families of server platforms by OEM; annual cost figures assume \$300,000 per hour per server of unplanned server downtime⁵

Server Make	Mean of Annual Unplanned Server Downtime	Annual Cost of Unplanned Server Downtime per Server
HPE® Compute Scale-up Server 3200	1.44 minutes	\$7,200
Lenovo® ThinkSystem™ SR950 V3	1.10 minutes	\$5,500

Note that the HPE Compute Scale-up Server 3200 server is a successor to scale-up configurations of the HPE® Superdome® family of servers, and so we used the Superdome server downtime figures from the 2022 ITIC Server Reliability Poll.

Appendix C: Three-Year Costs

Three-year estimated TCO for each server examined in this study breaks down by OEM as follows:

HPE

	HPE® Compute Scale-up Server 3200
MSRP (USD)	\$1,629,502.86
Power (W)	2,667.9 W
Cooling (BTU/h)	9,105.5 Btu/h
Three-year power and cooling (USD)	\$17,680.50
Labor (USD)	\$765,000.00
Downtime (USD)	\$21,600.00
Three-year TCO (USD)	\$2,433,783.36

Lenovo

	Lenovo® ThinkSystem™ SR950 V3
MSRP (USD)	\$875,925.02
Power (W)	3,126.6 W
Cooling (BTU/h)	9,857.3 Btu/h
Three-year power and cooling (USD)	\$19,930.29
Labor (USD)	\$765,000.00
Downtime (USD)	\$16,500.00
Three-year TCO (USD)	\$1,677,355.31

¹ Calculated from the maximum estimated three-year TCO of an HPE® Compute Scale-up Server 3200 server being 45% higher than a comparable Lenovo® ThinkSystem™ SR950 V3 server. See [Appendix C](#) for cost details.

² For example, a recent Flexera survey notes that 80% of small and medium-sized businesses (SMBs) and 82% of enterprises listed managing cloud spend as their number-one priority (the first time that cost has overtaken security as the top priority in the last 10 years). Source: Flexera. "Flexera™ 2023 State of the Cloud Report." 2021.

³ Note: According to Lenovo, the company will be adding the ability for users to upgrade Lenovo® ThinkSystem™ SR950 V3 servers from four sockets to eight sockets. However, this option was not yet available at the time of this study.

⁴ Intel® Xeon® processors are the only x86 processors certified for SAP HANA®. Source: SAP. "Certified and Supported SAP HANA® Hardware." Accessed March 2024.

⁵ Information Technology Intelligence Consulting (ITIC). "ITIC 2022 Global Server Hardware, Server OS Reliability Report." February 2023.

⁶ 4th Gen Intel® Xeon® Scalable processors versus 3rd Gen Intel Xeon Scalable processors average performance improvement = 1.53x. Source: Intel. [Performance Index \(4th Gen Intel Xeon Scalable Processors, G1\)](#). Accessed October 23, 2023. 3rd Gen Intel Xeon Scalable processors versus 2nd Gen Intel Xeon Scalable processors average performance improvement = 1.46x. Source: [Performance Index \(3rd Gen Intel Xeon Scalable Processors, 126\)](#). Accessed October 23, 2023. Net improvement from 2nd Gen to 4th Gen = 1.46 x 1.53 = 2.23.

⁷ Versus 3rd Gen Intel® Xeon® Scalable processors. Solely processor-based IOPS performance claims for 3rd Gen Intel Xeon Scalable processors versus 2nd Gen Intel Xeon Scalable Processors are unavailable. Source: Intel. [Performance Index \(4th Gen Intel Xeon Scalable Processors, N18\)](#). Accessed May 12, 2023.

⁸ Versus 3rd Gen Intel® Xeon® Scalable Processors. Level-1 compression throughput claims for 3rd Gen Intel Xeon Scalable processors versus 2nd Gen Intel Xeon Scalable processors are unavailable. Source: Intel. [Performance Index \(4th Gen Intel Xeon Scalable Processors, N16\)](#). Accessed May 12, 2023.

⁹ Intel. "4th Gen Intel® Xeon® Scalable Processors." December 2022.

¹⁰ Red Hat. "Use Case: Red Hat Enterprise Linux for SAP Solutions." Accessed January 2024.

¹¹ Red Hat. "Overview of the Red Hat Enterprise Linux for SAP Solutions subscription." September 2023.

¹² US Energy Information Administration. "Electric Power Monthly." November 2023.

The analysis in this document was done by Prowess Consulting and commissioned by Lenovo.

Results have been simulated and are provided for informational purposes only. Any difference in system hardware or software design of configuration may affect actual performance.



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