
White Paper

SUSE Linux Enterprise Server for
High Performance Computing
SUSE Enterprise Storage

Bring Secure, Scalable HPC to Your Enterprise with Leaders HPE and SUSE

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Offering the Power of HPC Infrastructure to the Enterprise

As high-performance computing (HPC) moves beyond government and academic research institutions, it brings with it enormous opportunity for enterprises today. Every dollar invested in HPC can return an average of US\$356¹ in revenue and US\$38 in profit, according to an IDC survey.²

With an HPC infrastructure, your organization can make better use of enormous amounts of data and tackle large and complex problems. And getting that HPC infrastructure is now easier than ever. Together, Hewlett Packard Enterprise (HPE) and SUSE offer secure, scalable and performant HPC solutions designed for ease of use.

Letting You Focus on the Results

For consultants who study the HPC market, the lack of HPC uptake has been known as the “missing middle.” A small percentage of companies use HPC very well, while a larger number have basic HPC systems but have not advanced beyond them. The rest are the missing middle.

Why the slow adoption? HPC has traditionally meant assembling custom supercomputers—a time-consuming and expertise-requiring task that only research institutions seemed willing to tackle. At the same time, organizations had to work with a number of specialized vendors to build an HPC system.

Neither is true today. Today, HPE and SUSE are perfectly positioned to help bring HPC—both supercomputers and Linux clusters—to organizations everywhere. Both HPE and SUSE have extensive HPC experience, and they work together closely on

HPC technologies. In fact, SUSE® Linux Enterprise Server is HPE’s preferred operating system for HPC environments³, and since 2003 it has been included in SGI systems as a native install option.

Both organizations are dedicated to making HPC adoption easier. Traditionally, scientists and researchers did much of the work building HPC infrastructure. But piecing together servers is not the wisest way to spend your experts’ time. They should be fighting cancer, pushing the edge of materials science, and pulling insights from massive data sets. The need for easy-to-use enterprise solutions, such as those from SUSE and HPE, continues to grow as the uses of HPC expand.

The Expanding Potential of HPC

Traditional high-performance computing workloads involve complex problems and algorithms. For these tasks to be run in a reasonable amount of time, they are broken down into pieces and run in parallel.

1 All prices are in U.S. dollars.

2 “What CIOs Should Know about High-Performance Computing,” *CIO Review*, <https://high-performance-computing.cioreview.com/cxoinsight/what-cios-should-know-about-highperformance-computing-nid-5572-cid-84.html>.

3 www.hpe.com/us/en/product-catalog/detail/pip.5379857.html

A Partnership of HPC Leaders

SUSE and HPE are both longtime leaders in high-performance computing. SUSE Linux Enterprise Server is in use in 50 percent of supercomputing's top 50 machines, while HPE is the single largest hardware vendor in the HPC market.⁴

SUSE is an OpenHPC founding member and major contributor. HPE's leadership in HPC is visible in its systems for deep learning, its systems with high GPU counts, and its work with the U.S. Department of Energy developing an exascale prototype.

The HPE SGI 8600 is the world's most advanced production supercomputer, and HPE built the first commercial off-the-shelf supercomputer used on the International Space Station.⁵

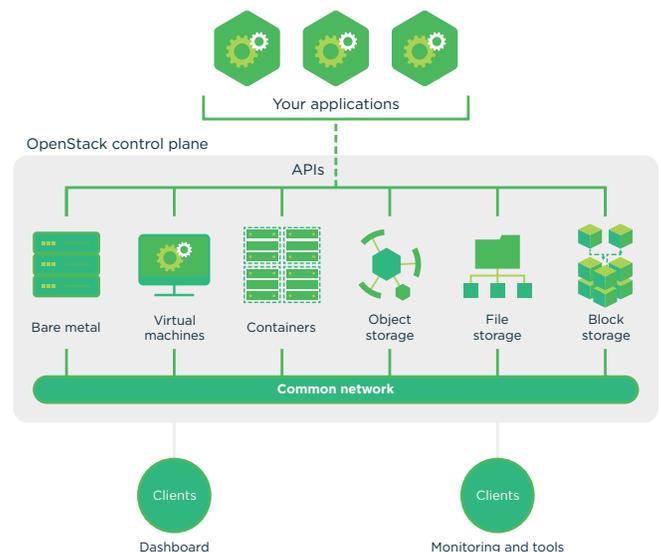
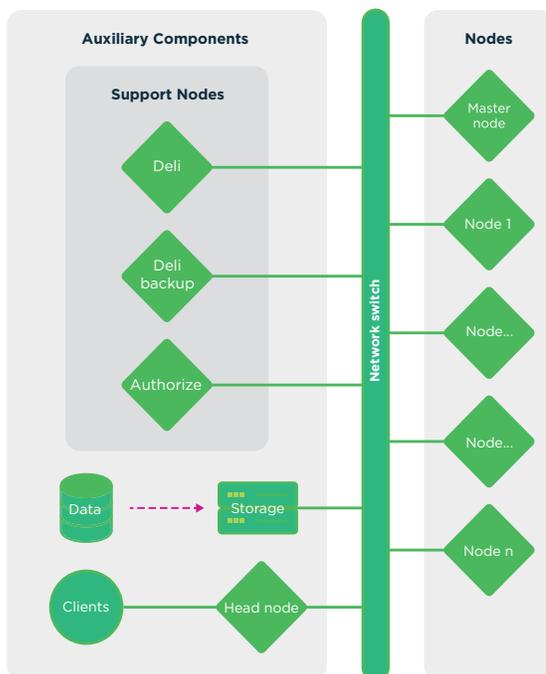
With the advent of big data, though, the field of high-performance data analytics (HPDA) has evolved. These workloads involve enormous data sets and simple computational operations performed sequentially. Sometimes grouped into HPDA are artificial intelligence workloads, such as machine learning.

Today, enterprises may want to run both kinds of workloads. Flexible, modern HPC infrastructure can let them do so. Because not only are there more ways to use an HPC infrastructure, there are also more ways to build one. HPC systems are quickly expanding beyond their traditional bare-metal roots to take advantage of virtualized platforms and containers. Today's HPC workloads might run on-premises or in public or private clouds.

There are now multiple HPC-as-a-service offerings based on public clouds. And expanding or migrating an existing OpenStack or Hadoop cluster into an HPC cluster is becoming more and

4 "Trends in the Worldwide HPC Market," Hyperion Research, September 2017, www.slideshare.net/insideHPC/trends-in-the-worldwide-hpc-market.
5 www.hpe.com/us/en/insights/articles/the-space-station-gets-a-new-supercomputer-1708.html

Figure 1. A diagram showing the similarities between the architecture of an HPC cluster on the left and the architecture of an OpenStack private cloud on the right.



more common. Gregor Mendel Institute is just one example of an organization that used SUSE OpenStack Cloud to provide an HPC-as-a-service infrastructure to its researchers.

Working Together to Capture All the Potential of HPC

The benefit of working with HPC experts from HPE and SUSE comes not just in their individual knowledge but also the way the two organizations' offerings fit together to create a complete HPC solution that offers better scalability, performance, security and ease of use.:

Scalability

SUSE software is priced to allow economic scaling, while the variety of HPE's hardware offerings allows you to grow the way you want. SUSE Linux Enterprise Server for High Performance Computing is priced the same for head and compute nodes, while SUSE Enterprise Storage is priced per node, not per gi-gabyte stored.

As HPE moves toward 100,000 node clusters to support the exascale systems of the near future, SUSE solutions can keep up with unlimited scaling and storage capacity. [Total](#), one of the largest public oil and gas companies, took advantage of the scalability in SGI hardware and SUSE software to build a system with 10 times the computing power of the company's previous system.

Performance

HPE and SUSE work with you to help you achieve the best performance of your system. Unlike community Linux distributions, SUSE Linux Enterprise Server is already optimized for performance in HPC environments. HPE's HPC applications-engineering team helps you optimize and benchmark your applications and workloads.

High-frequency trading is one example of a workload that demands extreme performance—and an example of an area where

the HPE and SUSE partnership excels. HPE servers running SUSE Linux Enterprise Server achieved the lowest max and lowest mean latency ever reported on the STAC-N1 tests.⁷

HPE software and the SUSE HPC Module further enhance system performance as described in the section on software that follows.

Security and Resilience

HPC workloads almost always involve valuable intellectual property, making security paramount. SUSE Linux Enterprise Server comes with cryptographic modules validated to the FIPS 140-2 standard and is certified Common Criteria EAL4+, the highest level of security for a commercial operating system. Enterprise support helps you quickly solve issues that would tie up systems relying on community versions of Linux.

HPE is the only vendor to provide silicon root of trust in its Gen10 servers, which creates a digital fingerprint in the silicon and ensures that the server will never boot with compromised firmware. This and other features have garnered HPE recognition as having the "world's most secure industry-standard servers."⁸

Ease of Use

Keeping your experts focused on their research and analytics tasks is key to obtaining the maximum return on investment for your HPC system. That is why HPE and SUSE design HPC solutions to be easy to use and fit into your existing environment.

SUSE Linux Enterprise Server is available for x86_64 and ARM64 architectures. HPE offers multiple x86_64 platforms and the new HPE Apollo 70, which is based on ARM64 processors. Both HPE and SUSE work with a variety of third-party solutions (such as the HPC interconnects crucial for communication within a cluster).

One of the most important ways SUSE and HPE work together and make your job easier is the way their software offerings combine to create a complete software stack for HPC users.

“As we look to model the physical world in ever-more detail, SUSE Linux Enterprise Server gives us the ability to keep scaling on ever-larger machines.”

DIEGO KLAHR

HPC Engineer

Total⁶

⁶ www.suse.com/success/stories/total/

⁷ "STAC Report: Overclocked HPE Servers with 25GbE and SLES," STAC, Oct. 9, 2017, <https://stacresearch.com/news/2017/10/10/HPE170814>.

⁸ Based on external firm conducting cybersecurity penetration testing of a range of server products from a range of manufacturers, May 2017.

Together, a Complete HPC Software Solution

The HPE software and the SUSE HPC Module combine to enable your HPC users to run massively parallel and HPDA workloads easily, without them having to worry about the underlying software.

Supporting Software from HPE

With HPE's acquisition of SGI, the company now offers a full portfolio of best-of-breed HPC software. The portfolio includes system management tools, an application acceleration suite and an out-of-the-box software stack for HPC systems.

- **Software stack**—HPE Performance Software Suite
- **System management**—HPE SGI Management Suite, HPE Insight Cluster Management Utility, HPE ProLiant and Apollo systems also come with built-in system management tools.
- **Software development**—HPE Performance Software—Message Passing Interface (HPE MPI).
- **Visualization**—SGI VizServer with NICE Software, HPE High Performance Remote Visualization Solution
- **Data management**—HPE Data Management Framework, SGI XFS and SGI CXFS

SUSE HPC Module

The SUSE HPC Module includes high-demand packages for HPC workloads. These are packages that are a part of the OpenHPC stack, but unlike the software available through OpenHPC, all packages in the SUSE module come with enterprise support from SUSE. SUSE continually works with the HPE HPC team and customers to evaluate which packages to add to the module.

This is the list of the current packages available in the SUSE HPC Module:

- *Console access:* `conman`
- *CPU identification:* `cpuid (x86-64)`
- *Portable hardware locality:* `hwloc`
- *User environment management:* `lua-lmod`
- *File system library:* `lua-luafilesystem`

Visualization	SGI VizServer	HPE High Performance Remote Visualization
Software stack	SUSE HPC Module (hwloc, lua-lmod, lua-luaposix, memkind, rasdaemon, and more)	
Data management	HPE Data Management Framework	SGI XFS and SGI CXFS
	SUSE HPC Module (lua-filesystem)	
Application and software development	HPE Performance Software—MPI	
	SUSE HPC Module (Slurm)	
System software	HPE Insight Cluster Management Utility	HPE SGI Management Suite
	SUSE Linux Enterprise Server	

- *Bindings for POSIX APIs:* `lua-luaposix`
- *Terminal management:* `lua-luaterm`
- *Memory allocation:* `memkind (x86-64)`
- *Remote shell programs:* `mrsh`
- *Authentication service:* `munge`
- *Parallel remote commands:* `pdsh`
- *Power management for clusters:* `powerman`
- *Parallel task executor:* `prun`
- *Monitor kernel RAS:* `rasdaemon`
- *Workload manager:* `slurm`

SUSE has a flexible release schedule for the HPC Module. Releases are independent of the base SUSE operating system service pack schedule, allowing SUSE to update the module more frequently so you get the latest HPC technology as quickly as possible.

SUSE Package Hub

The SUSE Package Hub offers access to additional HPC packages that are frequently requested by HPC users and supported by the open source community. This includes the popular container engine Singularity. Find out more at <https://packagehub.suse.com/>.

A Powerful Hardware Foundation

All of this software can run on a variety of HPC server configurations. HPE offers one of the largest and most comprehensive portfolios of servers for HPC computing in the world. That portfolio includes:

- **HPE SGI 8600**—*The world’s most advanced production supercomputer has been architected for the best possible performance, scale and efficiency.*
- **HPE Apollo 2000**—*This high-density, scalable two-unit server gives you greater performance and workload capacity than standard one-unit servers—at a comparable cost.*
- **HPE Apollo 4000**—*Run Hadoop and other big data analytics while maximizing disk storage and implementing object storage with petabyte-scale data volume.*
- **HPE Apollo 6000**—*These servers offer the exceptional price and superlative compute performance of rack-level air-cooled density. Tailor your system precisely to meet your most demanding HPC workload requirements.*
- **HPE Apollo 10 Systems**—*These industry-standard accelerated compute servers allow even the smallest department to run deep-learning and mixed-workload HPC.*
- **HPE Apollo 70**—*Achieve the density and scalability required for large HPC cluster deployments with ARM HPC processor technology. Get maximum memory bandwidth and familiar management and performance tools.*
- **HPE Superdome Flex**—*This single system enables you to solve complex, data-intensive HPC problems at unparalleled scale by leveraging 4–32 sockets and 1–48 TB of in-memory computing capacity.*

Software-Defined Storage for HPC Environments

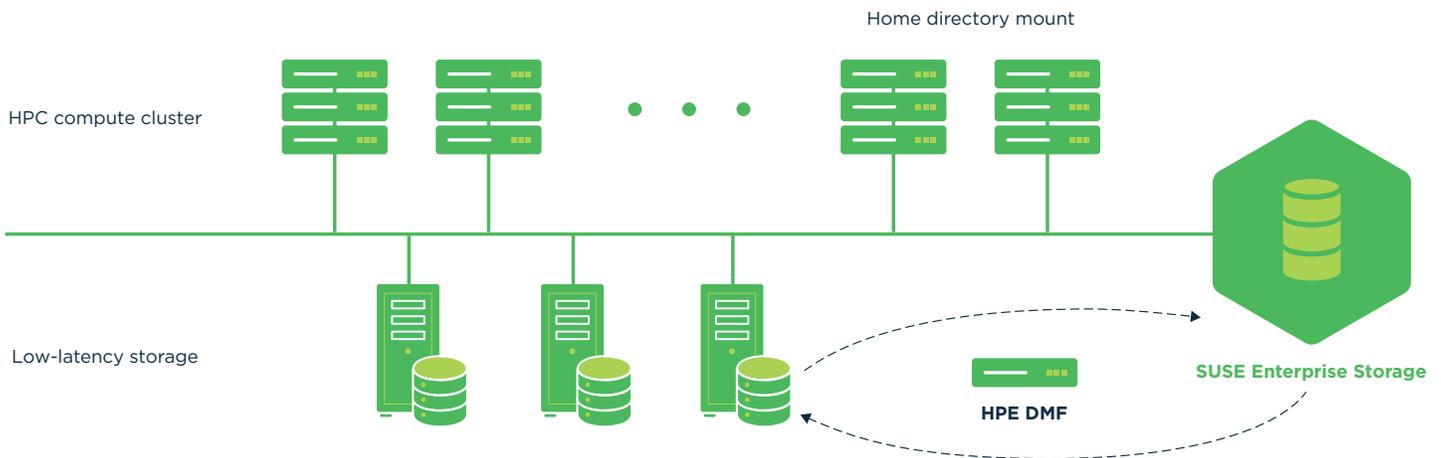
SUSE Enterprise Storage, based on the open source project Ceph, allows you to deploy a unified block, object and file storage environment. It has a flexible, cluster-based design for graceful and inexpensive upgrades and near-linear scaling.

Adding to an existing array expands capacity and performance. The solution architecture automatically integrates additional hardware and grows to meet future demand. You can build your software-defined storage system with the cost efficiencies and reliability of HPE hardware, rather than branded disk arrays.

SUSE Enterprise Storage on HPE hardware is an ideal solution for home directories or archival storage in HPC systems. It can provide the constant, bidirectional flow of data that HPC systems often demand, and it works with the HPE Data Management Framework.

Reference architectures and more are available for HPE and SUSE Enterprise Storage solutions, including:

- [“SUSE Enterprise Storage on HPE Apollo 4200/4500 System Servers: Choosing HPE Density-Optimized Servers as SUSE Enterprise Storage Building Blocks”](#)
- [“SUSE Enterprise Storage v4 Implementation Guide: HPE Apollo 4000 Series Platforms”](#)
- [“HPE Best Practices for Deploying SUSE Enterprise Storage on HPE Synergy”](#)



Supporting Your Move to HPC

HPE and SUSE work to help you capture the potential of HPC infrastructure without the hassle. In addition to the ease of use built into their solutions, both organizations offer consulting services. Tap into years of HPC experience and launch your enterprise forward by teaming up with SUSE and HPE.

Learn More

Learn more about SUSE Linux Enterprise Server for High Performance Computing at www.suse.com/products/server/hpc/.

9 www.suse.com/media/success-story/pittsburgh_supercomputing_center.pdf

“SUSE Linux Enterprise Server is the only distribution that supports the full capabilities of the SGI machine. It was a no-brainer for this application. We use it. We recommend it. SUSE has a newer kernel than other options, making it the best choice.”

JIM KASDORF

Director of Special Projects
Pittsburgh Supercomputing Center⁹

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