
White Paper

SUSE Linux Enterprise Server for
High Performance Computing
SUSE Enterprise Storage

SUSE and Lenovo Deliver Some of the World's Most Powerful Supercomputers

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Put the Power of High-Performance Computing to Work for Your Business

The demand for high-performance computing (HPC) has grown beyond its traditional home of research institutions and government labs. Today, enterprises of all sizes are realizing the value of HPC for a variety of tasks, such as financial forecasting, physical simulations, fraud detection, business intelligence, engineering, marketing and personalized medicine—and the most common use, data analytics.

With an HPC infrastructure, enterprises can leverage massive volumes of data to quickly solve large and complex problems like modeling or simulations. SUSE and Lenovo have partnered to offer a comprehensive HPC infrastructure that can get you started quickly and easily.

The Changing Face of HPC

HPC is now almost entirely Linux based. In fact, 100 percent of Supercomputing's Top 500 supercomputers run Linux.* Where HPC systems were once large, specialized systems used in labs, they are now mostly composed of very large Linux clusters of small, standard systems. This makes HPC

more cost-effective for enterprises, and for the first time, they can benefit from those powerful capabilities while staying within budget.

HPC is being used in many industries, mostly where organizations have a lot of data or complex projects to complete, including energy, oil and gas; healthcare and life sciences; higher education and research; finance; and manufacturing, and in the development of artificial intelligence (AI).

Enterprises employ HPC for a variety of tasks, including to:

- *Develop and redesign products.*
- *Optimize production and delivery processes.*

- *Analyze or develop large data sets.*
- *Develop the AI applications of the future.*
- *Monitor and profile consumer trends.*
- *Create computer visualizations.*
- *Carry out simulations or modeling of complex processes.*

As more enterprises move to HPC, it's becoming clear that not all HPC systems are created equal. That's why SUSE and Lenovo developed their joint solution. Our aim is to empower you to spend more time on the work that matters, and we do that by delivering the most HPC compute power and capacity possible at the lowest cost and energy usage—plus providing ease of use and expert support from industry leaders.

* www.top500.org/statistics/details/osfam/1

Why SUSE and Lenovo?

SUSE and Lenovo are uniquely positioned in the HPC space. Both companies were OpenHPC founding members and continue to be major contributors in the open source HPC community.

SUSE® software runs on 50 percent of the world's top 50 largest supercomputers, and SUSE Linux Enterprise Server is the only Linux distribution that includes supported HPC packages within the distribution. The SUSE High Performance Module refresh cycle helps you keep up with rapidly evolving HPC technologies and avoid extensive retesting of your platform.

Lenovo is one of the fastest-growing HPC providers in the Top 500 HPC, coming second worldwide and first in China. It's also the leading Top 500 supercomputer provider in Italy, Spain, China, Norway, Germany and Denmark. Lenovo took home five HPCwire "Best of HPC" awards at SuperComputing 2017, including best HPC server for the ThinkSystem SD530 and best HPC storage product for Lenovo Distributed Storage Solution for IBM Spectrum Scale (DSS-G).

Together, Lenovo and SUSE worked with the Barcelona Supercomputing Center to develop MareNostrum 4, the highest-performing supercomputer in the world based on next-generation Intel Xeon Scalable processors. Each of the 3,456 Lenovo ThinkSystem SD530 nodes performs more

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than 3.2 trillion calculations per second, providing a total cluster capacity of 11.1 petaflops. It's more impressive when you consider that the cluster was delivered, wired, and up and running before Intel announced the processor to the general public.

Lenovo built the first warm-water-cooled supercomputer together with the Leibniz Supercomputing Centre, or LRZ. The new SuperMUC-NG installation will provide LRZ with a staggering 26.7 petaflop compute capacity powered by almost 6,500 nodes of Lenovo's next-generation ThinkSystem SD650 servers—all in a smaller data center footprint with drastically reduced energy usage.

The joint SUSE-Lenovo HPC solution uses OpenHPC components for flexibility and lower total cost of ownership (TCO). It also provides supported versions of the most popular OpenHPC packages, such as SLURM for workload management and job scheduling. In addition to supporting popular software components, the solution is enabled with best-of-breed fabrics, including Ethernet, InfiniBand and Intel Omni-Path Architecture fabrics, to deliver the best performance for your demanding workloads.

And finally, SUSE and Lenovo are continually working together to refine their HPC offerings. The Lenovo HPC team identifies a rising need for particular features and capabilities, and SUSE integrates those into its HPC module.

Get the Best of HPC without the Hassle

With SUSE and Lenovo, you can realize the powerful potential of HPC without the difficult implementation and management. The solution allows you to:

- *Get popular OpenHPC packages with technical support and added functionality from leading technology providers.*
- *Get robust, high-capacity HPC infrastructure in a small footprint.*
- *Reduce the cost and risk of HPC investments by expanding the capabilities of existing infrastructure components.*
- *Simplify administration with a single platform that lets you efficiently manage HPC and AI workloads.*
- *Build storage that scales affordably to support your HPC system.*
- *Take advantage of expert configuration and implementation services to ensure that all components work together seamlessly.*

Components of the SUSE-Lenovo Solution

SUSE Linux Enterprise Server for High Performance Computing

The SUSE Linux Enterprise Server for High Performance Computing is the same distribution as SUSE Linux Enterprise Server, but it is sold with different terms, conditions and prices that are tailored for the unique requirements of HPC environments.

It includes the SUSE HPC Module with 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.

Packages in the HPC module include (but are not limited to):

- *Console access: conman 0.2.7*
- *CPU identification: cpuid 20151017 (x86-64)*
- *Portable hardware locality: hwloc 1.11.5*

- *User environment management: lua-lmod 6.5.11*
- *File system library: lua-luafilesystem 1.6.3*
- *Bindings for POSIX APIs: lua-luaposix 33.2.1*
- *Terminal management: lua-luaterm 0.7*
- *Memory allocation: memkind 1.7.0 (x86-64)*
- *Remote shell programs: mrsh 2.12*
- *Authentication service: munge 0.5.12*
- *Parallel remote commands: pdsh 2.31*
- *Power management for clusters: powerman 2.3.24*
- *Parallel task executor: prun 1.0*
- *Monitor kernel RAS: rasdaemon 0.5.7*
- *Workload manager: slurm 16.5.5.1*

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/>.



Lenovo Hardware

SUSE Linux Enterprise Server for High Performance Computing runs on Lenovo's award-winning servers, which are specifically designed for high-performance workloads. Whether you're looking for energy efficiency, highly dense computing, reduced TCO or GPU-enabled hybrid solutions, the Lenovo ThinkSystem portfolio has a wide array of options:



ThinkSystem SD530—This ultradense two-unit, four-node platform delivers more compute power in less space and supports the use of GPUs for diverse workload requirements.



ThinkSystem SD650—This direct-water-cooled server delivers between 10 and 15

percent better performance and up to 50 percent energy savings compared to air-cooled systems.



ThinkSystem SR650—With its unique AnyBay design—which allows for multiple storage types in the same drive bay, including front-accessible Peripheral Component Interconnect Express (PCIe) solid-state drives—this server lets you flexibly configure your storage the way you want it.



ThinkSystem SR630—Ideal for management nodes, the two-unit SR650 has extensive memory and storage capacity, and supports up to two GPUs.

Lenovo Scalable Infrastructure (LeSI)

LeSI is a framework for the development, configuration, build, delivery and support of integrated data center solutions. It can help take the complexity out of planning an HPC implementation. With LeSI, you

“We have relied on SUSE Linux Enterprise Server in high-performance computing for approximately 15 years, and have always been very satisfied with the operating system.”

HERBERT HUBER

*Division Head of Super Computing
Leibniz Supercomputing Centre*

get the advantage of decades of Lenovo server experience and the flexibility to choose from a range of configured systems, from factory-integrated solutions up to fully end-to-end supported solutions that match best-in-industry components with optimized solution design.

Lenovo intelligent Computing Orchestration (LiCO)

LiCO is smart software that simplifies the management of AI and HPC clusters, workloads and users. It efficiently manages workflows for AI training tasks and allows users to leverage pretrained models, monitor training and manage job history for rapid deployment.

It also simplifies open source deployment with validated stacks that help users save time up front, plus a variety of AI framework options through the use of containers. LiCO offers flexibility in hardware infrastructure by supporting both NVIDIA GPUs and Intel Xeon Scalable processors to suit varying workloads.

LiCO also scales more efficiently for distributed model training and optimizes cluster resource management between multiple jobs—which puts your hardware to optimal use for a better TCO.



Lenovo Storage

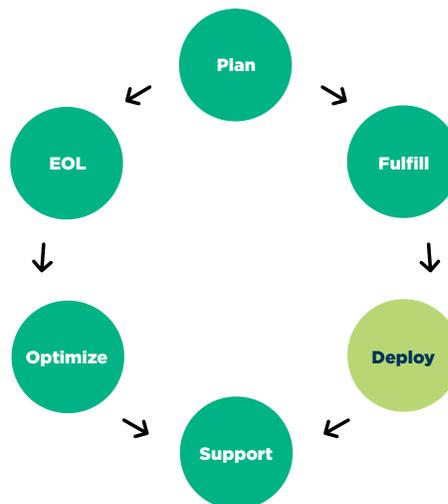
Lenovo DSS-G is a software-defined storage (SDS) solution for dense scalable file and object storage that's suitable for Tier 0 high-performance and data-intensive environments. It is based on IBM's General Parallel File System (GPFS) and comes as

a preintegrated, easy-to-deploy rack-level solution that dramatically reduces time to value and TCO.

Alternatively, Lenovo offers another storage option, DSS-C, which is based on SUSE Enterprise Storage. DSS-C is a lower-cost SDS solution with both primary and active-archive solution use cases for HPC environments. In the active-archive scenarios, DSS-C allows you to offload data from the DSS-G storage and place it on a system where you can perform further analysis as needed.

Lenovo Services

When you choose the joint SUSE-Lenovo solution for HPC, you get expert support and guidance from step one. Lenovo HPC Deployment Services offers basic hardware installation and custom advanced installation, migration and expansion services for rapid implementation. These services help increase implementation speed and quality while reducing risk. Lenovo professionals bring vast experience, provide field-tested



The Leibniz Supercomputing Centre deployed innovative warm-water-cooling technology from Lenovo and has taken advantage of frequency scaling and other power-saving features of SUSE Linux Enterprise Server to increase energy efficiency. Now its new supercomputer delivers approximately 20 times more performance per watt than its predecessor.

implementation best practices and recommend verified software to help you avoid trial-and-error iterations.

Make the Most of HPC with SUSE and Lenovo

We are committed to making HPC easy for enterprises, so you can focus on the work that matters—not on managing and operating your system. You have a lot of choices when it comes to HPC infrastructure, so make sure you choose a solution that gives you all the tools you need to be successful and that helps you extract real value from your big data and complex workloads. SUSE and Lenovo know HPC and can help your business thrive as you put HPC to work for you.

Learn more about SUSE Linux Enterprise Server for High Performance Computing at www.suse.com/products/server/hpc/. Also visit www.suse.com/lenovo or email us at lenovo@suse.com.

Additional contact information and office locations: www.suse.com

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