

# Taking research further with extraordinary compute power and efficiency.

How **Karlsruhe Institute of Technology** helps researchers tackle complex questions faster with a new supercomputer built on Lenovo ThinkSystem servers.

Lenovo Infrastructure Solutions  
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## Background

Karlsruhe Institute of Technology (KIT) is an elite public research university located in the state of Baden-Württemberg, Germany. It was officially established in 2009 following the merger of the former University of Karlsruhe and the Karlsruhe Research Center. Today, KIT employs more than 9,800 people and hosts more than 22,000 students, engaged in a broad range of disciplines in natural sciences, engineering, economics, humanities, and social sciences.

KIT combines the traditions of a renowned technical university and a major large-scale research institution. In both research and education, KIT aims to make significant contributions to managing the challenges facing society and the environment.



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## Challenge

For institutions like KIT, high-performance computing (HPC) has become indispensable to cutting-edge research. To understand natural and technical processes in all their complexity, researchers need ever-greater amounts of computing power and capacity. And that's exactly what the Steinbuch Centre for Computing (SCC), KIT's information technology center, delivers.

Alongside providing core IT services for the university, the SCC operates HPC and large-scale data analysis infrastructures to support the needs of researchers all across the world—from KIT and the other universities in Baden-Württemberg to national and international research institutions.

To meet the evolving needs of these research communities, the SCC recently decided to upgrade its flagship Tier-2 HPC infrastructure, replacing the existing “ForHLR” supercomputing cluster with a next-generation platform.

Prof. Dr. Martin Frank, Director of the SCC at KIT, elaborates: “Not only does modern research require very high amounts of raw computing power, it also generates enormous amounts of data. Depending on the application, several hundred terabytes of data can be generated by a single simulation. It's critical that we provide HPC resources that allow our researchers to complete increasingly complex and data-intensive workloads.”



“We faced a number of constraints in looking for a new HPC platform. It needed to fit within our existing data center space and had to meet strict energy consumption limits. Equally critical was ensuring that the system fit the needs of our users, and delivered optimal performance for strategic workloads across a variety of research disciplines.”

**Prof. Dr. Martin Frank**

Director of Steinbuch Centre for Computing, KIT



## Why Lenovo? The best match for demanding requirements.

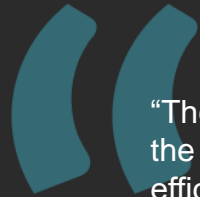
KIT issued an open tender for the new supercomputing platform, setting out its requirements and constraints. Following a round of initial bids, the university invited a selection of vendors to submit more detailed proposals and narrowed the choice down to a final group of contenders.

At the end of this intensive process, which was closely regulated by the EU, a joint proposal from Lenovo and Lenovo Gold Business Partner pro-com DATENSYSTEME GmbH was chosen. Lenovo and pro-com assembled a joint implementation team to guide the system configuration, and brought in key contacts from hardware partners Intel and NVIDIA to support the project delivery.

The implementation of the €15-million supercomputing cluster was completed on schedule in just nine months. After conducting extensive testing of the new system with support from Lenovo and pro-com, KIT officially unveiled its supercomputer, known as the “Karlsruhe High-Performance Computer” (Hochleistungsrechner Karlsruhe, HoreKa).

“Completing a project of this magnitude in roughly nine months was a great achievement, and speaks to the dedication and hard work of the entire team,” states Prof. Dr. Martin. “Not only was this a very large and complex technical implementation, we also carried it out in the first months of a global pandemic, when both supply chains and all ways of working together were hugely disrupted. We’re very grateful for the effort that everyone put in to make this a success.”





“The eco-credentials of the Lenovo solution and the performance optimizations made to the overall system were an ideal match to accomplish our objective of delivering highly efficient and sustainable HPC solutions.”

**Prof. Dr. Martin Frank**

Director of Steinbuch Centre for Computing, KIT

## Cutting-edge capabilities.

HoreKa resides in a state-of-the-art data center constructed for its predecessor, ForHLR, on KIT's Campus North. It is built on Lenovo ThinkSystem SD650-N V2 and SR670 V2 servers, featuring Lenovo Neptune™ liquid cooling technology.

HoreKa is an innovative hybrid system that consists of two modules. HoreKa-Green comprises computing accelerators based on 668 NVIDIA A100 Tensor Core GPUs. HoreKa-Blue, on the other hand, is a CPU-based module, made up of almost 60,000 3rd Gen Intel Xeon Scalable Processor cores.

A non-blocking NVIDIA Mellanox InfiniBand HDR network with 200 GBit/s per port is used for communication between the nodes. Two IBM Spectrum Scale parallel file systems offer a total storage capacity of more than 16 PB.

When it was first unveiled, HoreKa-Green ranked 52nd in the TOP500 list of most powerful supercomputers in the world<sup>1</sup>, and 13th on the Green500 list of most energy-efficient HPC systems.<sup>2</sup> HoreKa-Blue ranked 219th on the TOP500 and 65th on the Green500.

The HoreKa supercomputer is part of Germany's National High-Performance Computing infrastructure (NHR) and available to scientists from all over the country. The system supports research across many different scientific fields, including Earth System Sciences, Material Sciences, Engineering in Energy and Mobility Research, the Life Sciences, and (Astro-)Particle Physics.

<sup>1</sup> Source: TOP500 June 2021, <https://www.top500.org/lists/top500/list/2021/06/>

<sup>2</sup> Source: Green500 June 2021, <https://www.top500.org/lists/green500/list/2021/06/>





“Users get an immediate 4x performance increase when running their code on the HoreKa cluster’s CPUs alone, thanks to the new 3rd Gen Intel Xeon Scalable processors. Once they take advantage of the NVIDIA A100 Tensor Core GPUs, they can see even greater speedups. We are working with the scientific communities to help them optimize their codes and start their journey to seriously accelerate workloads.”

**Prof. Dr. Martin Frank**

Director of Steinbuch Centre for Computing, KIT



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## Results

With HoreKa, KIT has dramatically boosted the computing power and data throughput available to researchers. The new HPC cluster offers a total peak performance of 17 PFLOPS—a huge improvement on the previous cluster’s peak performance of 1.2 PFLOP.

In addition, HoreKa efficiently handles the ever-growing amounts of data generated by research projects, delivering up to four times the throughput of its predecessor system. Data throughput and total storage capacity have also improved by a factor of 2-6, respectively.

Equally importantly for KIT, the new supercomputing cluster delivers this vastly improved performance within a dense, energy-efficient footprint, thanks to state-of-the-art Lenovo Neptune liquid-cooled servers supporting the latest NVIDIA A100 Tensor Core GPUs and advanced 3rd Gen Intel Xeon Scalable processors.

Prof. Dr. Frank explains: “Our previous supercomputer already used direct-water cooling [DWC], but the new Lenovo system marks an important step forward. It has helped us rank 13th on the Green500 list, which is a huge achievement and signals our commitment to sustainable HPC. Lenovo Neptune technology enables us to cool the supercomputer with minimal energy use. What’s more, we use the waste heat from the water-cooling system to heat office buildings in the colder months—helping us to reduce our carbon footprint even further.”

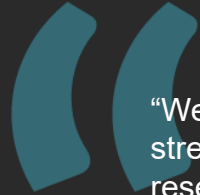
The HoreKa cluster currently supports hundreds of research projects all across the nation. They include a number of climate science projects, including a project aimed at predicting when the planet's ozone layer will be fully healed. With HoreKa, projects such as these can process larger amounts of data than ever before and analyze far more details in larger systems, enabling researchers to deepen their understanding of highly complex natural and technical processes.

Prof. Dr. Frank says: "The design of the Lenovo HPC system supports data-hungry workloads, such as climate simulations, which either use a lot of input data or generate a lot of data. It means that researchers can run bigger jobs faster, as well as achieve much finer resolutions for simulations, allowing them to study complex systems in a much higher level of detail."



- ✓ **17 PFLOPS peak performance**
- ✓ **Up to 17x performance increase from previous HPC system**
- ✓ **3-4x improvement in data throughput**
- ✓ **Close to 60,000 Intel CPU cores and 668 NVIDIA GPUs accelerate vital research**





“We are proud to develop our HPC capabilities with Lenovo. The HoreKa cluster strengthens KIT’s reputation as a leading research institute and allows us to support researchers with advanced computing capabilities that drive scientific progress.”

**Prof. Dr. Martin Frank**

Director of Steinbuch Centre for Computing, KIT

## What will you do with Lenovo HPC solutions?

The Data-Centered speed up scientific discovery  
with Lenovo smarter infrastructure solutions.

[Explore Lenovo HPC Solutions](#)

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