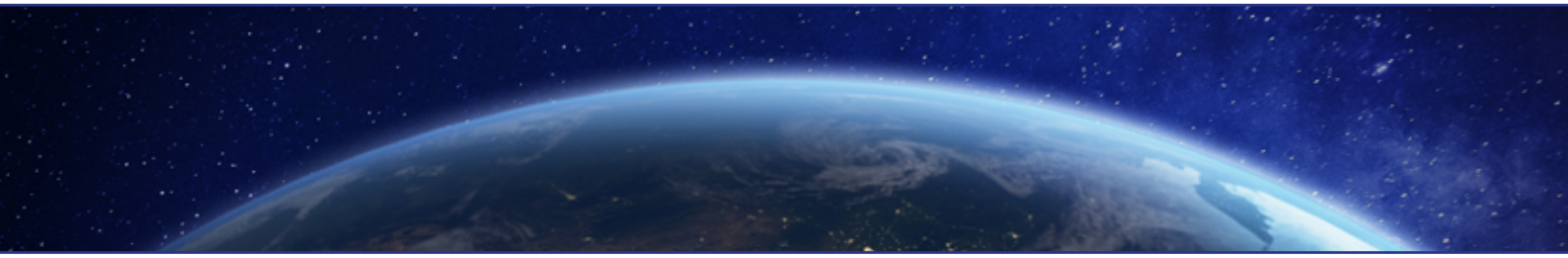

University of Cologne puts secure and highly efficient HPC system into operation

The University of Cologne is one of the largest universities in Germany. Founded in 1388, it was the sixth university to be established in Central Europe. It constantly ranks among the top 20 German universities in world rankings, holding the status of a University of Excellence as part of the German Universities Excellence Initiative from 2012 to 2019.

The Regional Computing Centre Cologne (RRZK) is the central IT service provider of the University of Cologne, managing infrastructure and offering HPC (High-Performance Computing) services to various research groups within the University.

At the RRZK, the University of Cologne recently put into service the new HPC cluster RAMSES (Research Accelerator for Modelling and Simulation with Enhanced Security).

Long-term experience gained in collaborations with life scientists and medic has been leading the way for the technical design of RAMSES. Consequently, the new HPC system provides a lasting research infrastructure with an architecture focused on security and AI. It will be particularly useful for the fields of astronomy, quantum physics, medicine, and life science. Among other projects, RAMSES will be used to analyse genomic data, to explore quantum computing algorithms, or to develop and simulate highly complex models of our universe.

The Requirements:

Besides fulfilling the demand for a system with maximum performance within the given limits, the HPC environment required an elevated level of information security.
Comprehensive security measures were requested to ensure that sensitive data is always protected, especially during all communication processes between the different system components. Sensitive data, which is part of the computational workflow for research projects, required file-based encryption while in transit, but also at rest.

Image: Niclas Carl, University Cologne

The Solution:

From the outset, the system was designed to meet the highest security requirements in genomic research, where highly sensitive data is used to find cures for rare diseases, for example. At the same time, challenging cooling and performance requirements had to be considered.

NEC has delivered an HPC supercomputer containing 31,576 CPU cores and 167 Terabytes of main memory in total. The main computational workload is realized by KAYTUS 1U 2-socket servers, equipped with AMD EPYC 9654 / AMD EPYC 7713 CPUs, and KAYTUS 2U2S GPU servers with 40 x NVIDIA H100 and 32 x NVIDIA A30 GPUs in total. In addition, 2 x AMD Instinct GPUs and 2 x NEC Vector Engines were deployed for special workloads. The complete system delivers a peak performance of 4.8 PFLOPS.

The HPC storage is realized by DDN GS400NVX2 systems using IBM Storage Scale as a fully encrypted parallel file system. In addition to a 30 TB full flash file system for the users' home directories, running on a dedicated DDN GS400NVX2, two GS400NVX2 hybrid systems providing 14 PB capacity are used for scratch and project storage. The storage system delivers a write bandwidth of 140 GiB/s.

All data at rest and in transit is encrypted, on the file system as well as in the main memory. NEC has developed a security concept that can be customised to the respective size of an installation and the customer's requirements. The security concept is implemented in NEC's own container-based HPC deployment framework LXC3-neo. It is based on the separation of physical and logical system components into different levels.

For high-performance network communication, NVIDIA HDR100 InfiniBand is used throughout. The complete system has a direct-liquid cooling (DLC) solution, using an inlet temperature of 35 degrees and an outlet temperature of 52 degrees. The heat is then fed back into the primary water circuit for facility heating. This ensures that the energy for operating the system is used in the most efficient way possible.

"Analysing clinical genome data has not previously been a classic field of application for HPC systems. RAMSES changes this — with end-to-end encryption throughout the entire calculation process and a customised system architecture that is currently unique in Germany. NEC has designed and delivered a system architecture and an operating model customised for this area of application in research collaborations, and we are very happy to have NEC as a long-standing, entrusted partner who delivers high quality in hardware, software, and services."

Professor Dr. Stefan Wesner
Director of the Regional Computing Center Cologne
Head of the Division of Computer Science