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A Moon Shot for the Brain

Italian consortium contributes essential high performance computing resources to a multinational effort to develop the world's most detailed model of the brain.

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Sanzio Bassini
Director of the HPC Department
Cineca

Business needs

Italy's Cineca consortium needs leading-edge high-performance computing resources to empower scientific research conducted by public and industrial research institutions. The EU flagship Human Brain Project stands out as one of the key scientific challenges supported by Cineca.

Business results

• Enabling breakthroughs in neurological research

• Unlocking the mysteries of the brain

• Paving the way to new life-saving treatments

• Accelerating scientific discovery with powerful HPC resources

Solutions at a glance

• Dell EMC PowerEdge servers with Intel® Xeon® processors

• Dell EMC PowerSwitch networking

Accelerating scientific discovery with the power of HPC

For more than 50 years, Italy's Cineca consortium has provided public and industrial research institutions with leading-edge systems and technologies for high-performance scientific computing. In this role, Cineca delivers HPC resources, data management tools, and HPC services and expertise to enable the work of researchers in Italy and elsewhere in Europe.

The ultimate goal of Cineca's work is to help researchers accelerate scientific discovery and data-driven innovations. To that end, Cineca's HPC experts consult with users on the tools and techniques employed in several scientific disciplines — from medicine to meteorology, from seismology to fluid dynamics, from bioinformatics to chemistry and high energy physics — to drive science forward.

"At Cineca, we provide access to, and support for, the most advanced HPC systems in Italy," says Sanzio Bassini, director of the HPC department at Cineca. "We are a frequent flyer in the top ten of the Top500 list of the world's fastest supercomputers. And we provide the same HPC access and the same services to the European community that we provide to the national scientific community in Italy."

The Human Brain Project

One of the ongoing scientific initiatives supported by Cineca is the Human Brain Project, or HBP. This multinational initiative is focused on taking our understanding of the human brain to places we have never been before. At the highest level, the goal of this project is to implement for the human brain what the European nuclear research organization CERN has implemented for high energy physics — which is the largest particle physics laboratory in the world.

With this goal in mind, the Human Brain Project, coordinated by the Ecole Polytechnique Fédérale of Lausanne, is creating the world's largest experimental facility for developing the world's most detailed model of the brain. This model will allow scientists, physicians and others to better study how the human brain works and, ultimately, develop personalized treatments for neurological and related diseases. About 90 European and international research institutes are involved in the Project.

For its part in the latest phase of the Human Brain Project, Cineca is implementing and operating one of the project's planned four new advanced supercomputing systems: the HBP supercomputer for massive data analytics. This system, delivered by Dell Technologies, and equipped with large memory footprints based on Intel© Optane™ memory, is designed to provide efficient storage, processing and management of large volumes of data generated by the multi-national project.

As part of this effort, Cineca is collecting and analyzing HBP requirements, installing software tools and providing services based on ad hoc service policies, according to Mirko Cestari, HPC and cloud technology officer for Cineca.

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"To do that, we needed to understand the science and understand the technology behind it, and then put everything into an understanding of what we wanted from the computing infrastructure, and then make it available to the community. It was a complex process, but the team worked great, and we had a successful outcome."

The resulting Cineca HBP supercomputer is one of the key components of the European Interactive Computing E-Infrastructure (ICEI) for the Human Brain Project. This EU-funded ICEI project provides cloud-like services compatible with the work cultures of scientific computing and data science.

The HPC environment

The Cineca HBP supercomputer from Dell Technologies incorporates a rich mix of leading-edge products for high performance computing.

"For the HBP project, we are working with Dell to provide dual-socket CPUs server nodes, which are interconnected via HDR100," Cestari says. "We have also 36 compute notes with GPUs and 180 compute servers with Intel® Optane™ memory."

Here's a look at the specific server components in the system, all of which are based on Dell EMC PowerEdge servers with Intel® Xeon® Platinum processors and Intel® Optane™ DC persistent memory:

• 348 Dell EMC PowerEdge C6420 servers — dense, performance-optimized compute nodes designed to drive demanding HPC and scale-out workloads

• 273 Dell EMC PowerEdge R640 servers — dual-socket, 1U platforms for dense scale-out data center computing

• 36 Dell EMC PowerEdge R740 servers — systems with an optimal mix of accelerator cards, storage and compute power in a 2U, dual-socket platform

• 12 Dell EMC PowerEdge R740xd servers — systems that increase storage scalability and performance with up to 24 NVMe drives and a total of up to 32 drives in a 2U dual-socket platform.

"We offer a really vast ecosystem of servers," Cestari says. "This is done on purpose, to let the users be able to best run their workflows, which can be very diverse on our infrastructure."

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For hyperconverged storage, the new Cineca HBP supercomputer incorporates DDN EXAScaler storage. Fully integrated DDN EXAScaler appliances combine a fast hyperconverged data storage platform with truly parallel filesystem software in a package that's easy to deploy and manage, and backed by a world leader in data at scale.

The HPC system also includes Dell EMC PowerSwitch networking and a mix of other networking components.

Huge achievements

Since its launch in 2013, the Human Brain Project has provided a framework to help teams of researchers and technologists work together to scale up ambitious ideas from the lab, explore the different aspects of brain organization, and understand the mechanisms behind cognition, learning and plasticity. To date, the HBP has fueled research that has resulted in more than 1,400 journal publications, unique new research infrastructures and high-level scientific events.

Here are a few examples of the results of the research conducted under the HBP framework, gleaned from the Human Brain Project's Highlights and Achievements site.

- **HBP research contributes to new treatment for spinal cord injury** — A team of scientists has developed a treatment that allows patients to regain control of their blood pressure, using targeted electrical spinal-cord stimulation.

- **HBP-supported innovation: A brain prosthesis for the blind** — HBP research has helped lay the foundation for a brain implant that could one day give blind people their sight back.

- **Epilepsy: International researchers propose better seizure classification** — An epilepsy model developed by the Human Brain Project provides the basis for a novel framework, which could also push forward basic understanding of the disease.

- **New insights into autism through the HBP's human brain atlas** — Data obtained within HBP's brain atlas work has contributed to the discovery of a "short distance" brain connectivity deficit that is associated with a lack of social interaction and empathy.

This list of examples of achievements driven by the Human Brain Project could go on and on. And the future promises to bring more of the same, thanks in part to the ongoing expansion of the project's high performance computing resources that power and accelerate extremely demanding research workloads.

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