




SOLVING URUGUAY'S BIGGEST CHALLENGES

The Faculty of Engineering at Universidad de la República Uruguay is improving the lives of Uruguayans through research powered by HPC

Scientific research can make a big difference to people's lives by providing a better understanding of social problems such as health crises and a lack of job opportunities. To make a meaningful impact on Uruguayans, Facultad de Ingeniería (Faculty of Engineering) at Universidad de la República Uruguay (UDELAR) scaled up its HPC infrastructure to create a cluster that's open to all research groups across the country. Now, researchers are solving complex challenges such as COVID-19, supporting a shift to renewable energy, and expanding their work to improve Uruguayans' lives.

The high-performance computing (HPC) cluster of UDELAR's Faculty of Engineering had revolutionized research in Uruguay. For nearly a decade, the country's first centralized platform for scientific computing enabled researchers to solve complex problems in fluid mechanics, wind energy generation, bioinformatics, and more.

For example, this work helped address pressing industrial and economic challenges, catapulting Uruguay to its position as a world leader in wind power production. The country went from having nearly zero wind power prior to 2008 to now generating about 35% of its electricity from wind farms.

The Faculty of Engineering has been working with private and public institutions to develop applied research projects, focusing on environmental hydraulics, water management, climate change, renewable energy, among others.

"Through the cluster, we made a significant impact on research in basic and applied sciences in Uruguay," says Sergio Nasmachnow, a professor at the Faculty of Engineering. "As a result, many researchers were able to enhance the quality of their work and set new objectives with real-world applications."

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INDUSTRY: HIGHER EDUCATION

REGION: URUGUAY

VISION

Promote inclusive development and provide better public services to Uruguayans through scientific and related research

STRATEGY

Create an HPC cluster that is open for use by all researchers across Uruguay

OUTCOMES

- Supports the development of diverse research projects that tackle complex challenges such as COVID-19
- Helps Uruguay strengthen its energy supply and lower power costs by supporting a shift to renewable sources
- Increases CPU performance 3x and GPU performance 28x, enabling researchers to run large computations

Supporting scientific research with a national cluster

But as demand for scientific computation and applications increased, the HPC cluster struggled to keep up. “It was clear we had to significantly scale up the project in both computing capability and user coverage,” says Nesmachnow, a specialist in HPC and computational intelligence.

His team then proposed scaling up the faculty’s HPC infrastructure and extending its services to create a national cluster. Based on the plan, the cluster would support research and development activities of any scientific, industrial, technology, business, or social services group across Uruguay, giving them unlimited access to computing power.

“We wanted to support and promote research in Uruguay,” says Santiago Iturriaga, a researcher and adjunct professor at the Faculty of Engineering who is also part of the team. “With a national HPC cluster, we can accelerate research to address scientific and bigger challenges in our society.”

In 2018, UDELAR scaled the faculty’s cluster in partnership with Uruguay’s research bureau, Agencia Nacional de Investigación e Innovación (ANII), creating the largest HPC infrastructure in the country. State energy company Administración Nacional de Usinas y Trasmisiones Eléctricas (UTE) and telecommunications corporation Administración Nacional de Telecomunicaciones (ANTEL) acted as associate founding partners.

Powering inclusive change

True to the team’s aim of enabling inclusive development, many of the research projects devised using Cluster-Uruguay (Cluster-UY) are based on the idea of developmental university. The concept builds on the fairness and social impact of research excellence under an egalitarian model.

“Participants have the same rights and obligations, building a network of collaboration and improving access to the infrastructure,” says Nesmachnow. “Examples of projects we’ve developed using the model include providing greater accessibility to jobs for low-income individuals and a socioeconomic analysis of short- and long-term commodity prices and their impacts on the well-being of low-income citizens.”

Recognizing the difficulty of getting funding for scientific research, Nesmachnow’s team decided to make financial contributions voluntary for non-funded and non-commercial projects. Its goal was to encourage researchers to take advantage of the cluster, believing that research and democratizing knowledge can foster inclusive development.



Our country is now in a better position to develop innovative research initiatives, especially those focused on tackling social and other important problems.”

– **SERGIO NESMACHNOW**, PROFESSOR, FACULTY OF ENGINEERING, UNIVERSIDAD DE LA REPÚBLICA URUGUAY

Running larger and more data-intensive computations

With peak computing power of 166 teraflops, Cluster-UY has given researchers across the country the ability to expand their scope of work and address new challenges.

“Compared with our faculty’s old cluster, the CPU speed has tripled, and the GPU performance has improved 28 times,” says Iturriaga. “The networking infrastructure’s speed has also increased 10 times.”

As a result, researchers have been able to efficiently run large computations and use huge volumes of data necessary to explore more complex problems.

“Our country is now in a better position to develop innovative research initiatives, especially those focused on tackling social and other important problems,” says Nesmachnow.

Understanding the virus causing COVID-19

More recently, the cluster has powered research to better understand SARS-CoV-2, the virus that causes COVID-19, and to improve responses to outbreaks. Led by non-profit Institut Pasteur de Montevideo and UDELAR’s Faculty of

Science, the research project has been sequencing SARS-CoV-2 genomes of local COVID-19 cases, helping health authorities to better understand how the virus evolves and spreads in Uruguay.

“We now have a free database of biomolecular simulations of SARS-CoV-2 proteins, thanks to this project,” says Iturriaga.

This database has become a critical resource in Uruguay’s fight against COVID-19 by enabling further analyses and other useful simulations. One example is the search for low-cost antiviral drugs to treat COVID-19. Using Cluster-UY, researchers ran an in-silico analysis of the SARS-CoV-2 protein S interaction with the component molecules of a natural drug that is known to be effective against respiratory diseases.

The database also contributes to a global mapping and visualization of how SARS-CoV-2 genomes are changing around the world. This global and publicly available pool of information has been key to developing fast responses to COVID-19 across different countries.

Improving public services

Other research projects designed using Cluster-UY now also benefit Uruguayans from all walks of life through improved public services.

According to Nesmachnow, some of these projects have significantly informed decision-making in the energy sector—in particular, the production of renewable energy.

“Initiatives such as creating an operational wind forecasting system and analyzing the performance of a wind farm and its individual turbines through numerical simulations have helped strengthen energy supply and bring power prices down through a shift to renewable energy sources,” he says.

UTE led many of these projects and is expected to drive further research initiatives that will support Uruguay’s push toward more renewable energy. The country now obtains about 97% of its electricity from renewable sources.

“Big Data analyses of public transportation and household electricity consumption are also aimed at improving the efficiency and accessibility of public services in Uruguay,” adds Iturriaga. “And so are smart city projects such as devising intelligent ways to collect garbage and analyzing mobility data from intelligent transportation systems.”

The Uruguayan capital of Montevideo has won [smart city recognition](#) for its efforts to be equitable, inclusive, and environmentally sustainable.

Putting together a cutting-edge platform

To build the cluster, Nesmachnow’s team and technology firm Conatel S.A. chose HPE ProLiant DL380 Gen10 servers and NVIDIA Tesla GPUs for the hardware infrastructure.

“We had experience with HPE servers on the Faculty of Engineering’s cluster and knew how dependable they were,” says Nesmachnow. “We picked them for Cluster-UY for their great reliability, performance, and price.”

Cluster-UY comprises 28 HPE ProLiant DL380 Gen10 servers—each containing one NVIDIA Tesla GPU, two Intel® Xeon® Gold 6138 CPUs, 512 GB of RAM, and a 400 GB solid-state drive. It also has one service and two file server nodes. The cluster boasts the largest number of GPUs among scientific computing platforms in Uruguay.

“This has given us a competitive advantage in attracting new users since most local researchers have difficulty accessing high-end GPUs like NVIDIA Tesla,” says Iturriaga. “So far, we’ve executed 16,480,000 CPU hours with 51.5% occupancy and more than 152,500 GPU hours with 31.8% occupancy.”



With a national HPC cluster, we can accelerate research to address scientific and bigger challenges in our society.”

– SANTIAGO ITURRIAGA, ADJUNCT PROFESSOR, FACULTY OF ENGINEERING, UNIVERSIDAD DE LA REPÚBLICA URUGUAY



Expanding the cluster

As Cluster-UY aims to support more research projects with a HPC infrastructure, Nesmachnow's team is looking to update the cluster's hardware.

"Currently, we plan to incorporate some NVIDIA Tesla V100 to upgrade our GPU processing power and some AMD EPYC processors to update our CPU processing capability," says Nesmachnow.

"We will continue to work with HPE and NVIDIA® to make sure we provide Uruguay's scientific, academic, and other communities with the capability they need to improve and expand their work," he adds.

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SOLUTION

HARDWARE

- HPE ProLiant DL380 Gen10 servers
- NVIDIA Tesla GPUs

KEY PARTNERS

- NVIDIA
- Conatel S.A.



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