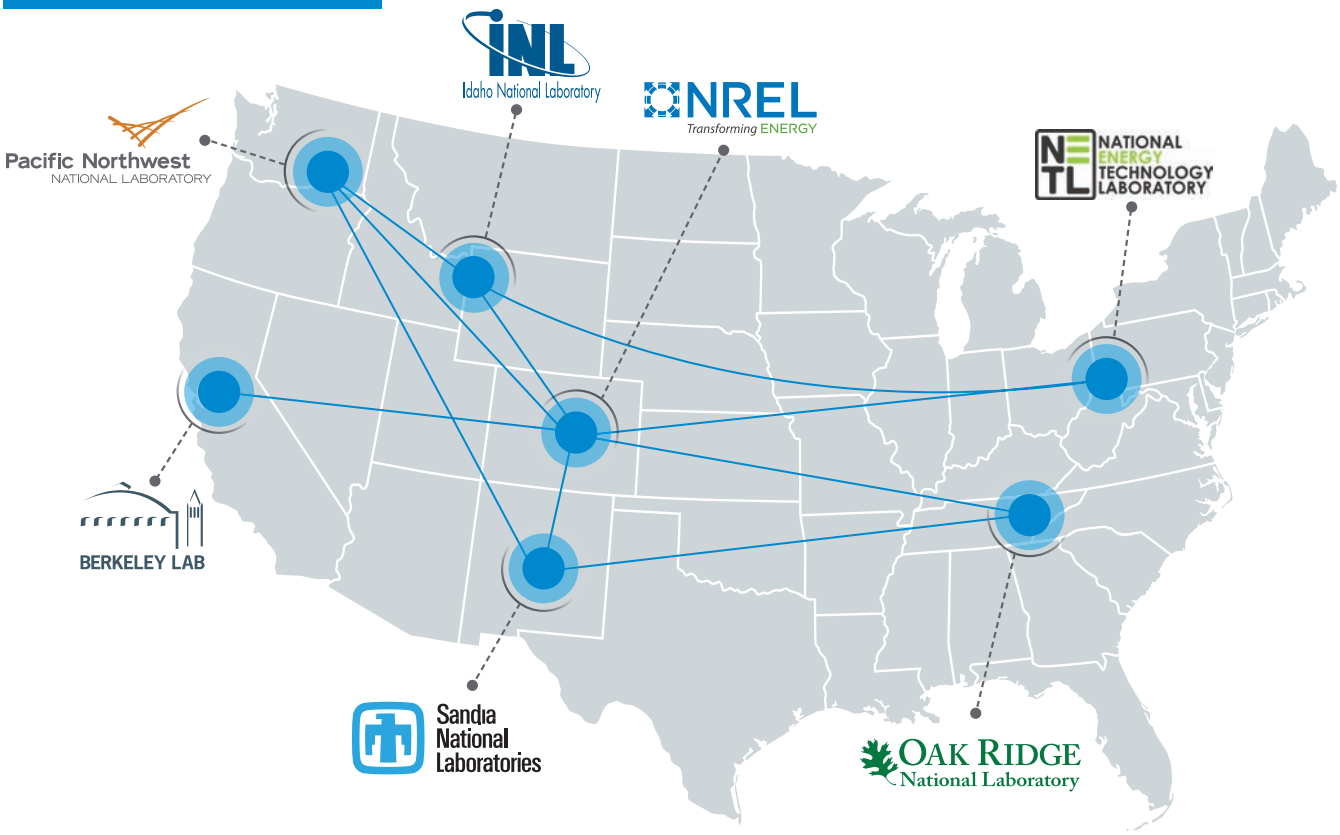

NREL: Working Towards a Superlab 2.0 With ESnet and Other National Laboratories

We can currently link models and simulations across the national laboratory complex, but imagine connecting these models with equipment, devices, and scientists so they can work together as if side by side instead of thousands of miles apart. In a future like this, researchers could run experiments that leverage thousands of devices to model the millions of devices that make up our increasingly complex energy systems.

With such resources, labs could simulate, for example, the electric grid of California and validate control strategies to best serve critical loads during outages caused by wildfires.

The National Renewable Energy Laboratory's (NREL's) Advanced Research on Integrated Energy Systems (ARIES) platform is making that vision a reality, one step at a time.

The SuperLab That Started It All

In September 2017, researchers performed a demonstration called the Global RealTime (RT) SuperLab. A total of eight laboratories across two continents used a Digital Real Time Simulation (DRTS) system connected over the internet for the demonstration.

The first SuperLab experiment was successful, but it uncovered a problem: in a word, latency. Latency is a measure of delay, and in this case, it was in transferring data using a standard internet connection across thousands of miles. Not only was latency in this experiment sometimes large, but it was also unpredictable. That variability made it difficult for researchers to conduct a meaningful experiment.

The Latency Fix: The Office of Science's ESnet

After the first SuperLab experiment, researchers began the search for solutions that would correct for latency and allow labs to run experiments together as if side by side.

That is where the U.S. Department of Energy's (DOE's) Office of Science's network facility, the Energy Sciences Network (ESnet), came in. ESnet is a high-performance, unclassified national network built and dedicated to support scientific research. ESnet has made critical contributions not only for the national laboratories but also internationally, including supporting the Large Hadron Collider, the world's largest and most powerful particle accelerator.

Combined with the On-demand Secure Circuits and Advance Reservation System (OSCARS) circuit, an advanced software system for booking time and resources on high-speed science networks, researchers could ensure consistent, low-latency performance during experiments.

Putting the Theory Into Practice

In December 2021, NREL's ARIES researchers teamed up with the Pacific Northwest National Laboratory (PNNL) and ESnet staff to demonstrate these capabilities during their live demonstration of a Cordova, Alaska, microgrid modeling experiment.

The December multi-laboratory demonstration showed that advanced control systems in the Cordova microgrid could allow it to maintain power to critical resources like the hospital and the airport during an extreme weather event and loss of some of its hydropower resources. During this tightly coupled experiment, NREL simulated the Cordova microgrid while PNNL simulated the advanced control systems.

This first-of-a-kind demonstration brought together the best of the laboratory complex, showcasing the ability to integrate expertise and capabilities at multiple DOE laboratories to address unique challenges that no one laboratory could address on its own.

ESnet provided a reliable, low-latency connection so that research equipment at the two laboratories could exchange frequent command and control information. The very low latency variance was vital to the research success and made exchange of command-and-control information between the two laboratories in the December demonstration nearly deterministic.

Future energy systems are increasing in complexity

On the heels of this successful demonstration, NREL's ARIES researchers and laboratory partners from Idaho National Laboratory have come together to plan for a second demonstration in early 2023. This demonstration will show how nuclear and inverter-based resource technologies (such as solar and storage) can work together to provide grid services (such frequency regulation and voltage control) while facilitating a clean energy transition and maximizing the flexibility, reliability, and resiliency of future energy grids..

Future demonstrations are planned with National Energy Technology Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, and Sandia National Laboratory. The team is looking to connect six national laboratories for experiments that use and model millions of interconnected devices. These experiments would be called "SuperLab 2.0."

Such an advanced research network could better identify solutions for city- and region-level problems. These experiments might include outages caused by extreme weather events or a cyberattack. It could also help energy systems managers who are adopting new technologies that rely on interconnected devices, so they can be assured that there are proven solutions to challenges that may arise.

For more in depth videos on the experiments and demonstrations visit nrel.gov/news/features/2022

Learn more about the ARIES platform nrel.gov/aries

For further information on this demonstration, please contact Rob Hovsapian or Steve Hammond with the National Renewable Energy Laboratory.

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NREL/FS-6A42-84972 • January 2023