Executive Summary

National Ignition Facility: Harnessing the Power of the Stars, Operating at the Speed of Light

Overview

Science fiction is becoming reality at the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory, where researchers are closing in on harnessing the power of thermonuclear fusion. Using hydrogen atoms and a laser 100 times more energetic than any other laser in the world, NIF scientists can create conditions on Earth that once existed only in the center of the stars.

To create thermonuclear fusion, the energy of 192 separate laser beams is focused to fuse together hydrogen atoms, producing helium and a massive amount of energy. For decades, fusion had been considered the stuff of science fiction, but in early 2014, NIF made headlines when it formally announced that record amounts of energy had been created through fusion.

Big Science Needs Big Data

Fusion is just one of many experiments taking place at NIF, which was built to sustain three missions: nuclear stockpile stewardship, energy science, and "basic" sciences such as experimental astronomy and astrophysics. Massive quantities of data are essential to the success of these experiments, from experimental design to experiment execution and analysis.

Before the laser can ever be fired, NIF's computer control system must coordinate more than 60,000 control points, including motorized mirrors and lenses, energy and power sensors, video cameras, laser amplifiers, pulse power, and diagnostic instruments. That's 60,000 parameters that must be set with high precision.

Due to high demand for the facility, the current experimental backlog is almost two years. Once accepted, scientists must spend considerable time planning and preparing for their experiments to be run. When it's time to run the experiment, scientists must make sure that the laser and target systems are perfectly calibrated and perfectly timed. "I cannot even conceive of how complex the IT has to be to get the laser to me," says Tammy Ma, staff scientist at NIF. "But I know that it's crazy, because when you're working with lasers, everything has to move at the speed of light." If data is unavailable due to IT downtime, planned or unplanned, months of work can be lost in the blink of an eye.

"We have a saying here," says NIF Chief Information Officer Tim Frazier. "What NIF generates is neutrons and a whole lot of data. When you look at the data that results from a NIF experiment, you see pictures taken by over 50 different types of instruments, like beautiful images of laser back-scatter or x-ray images of our targets as they implode," explains Frazier. The data from each experiment is captured and stored in databases for scientists to access immediately—and indefinitely.

Key Highlights

Challenge

Enable rapid, uninterrupted access to critical data to accelerate groundbreaking discoveries.

Solution

Migrate to private cloud based on NetApp® clustered Data ONTAP® with NetApp flash technology for optimal performance.

Results

- Delivered nonstop, 24/7 availability for critical data
- Cut planned downtime by 60 hours per year to maximize facility availability
- Reduced latency by 97% to keep experiments running
- Increased virtual storage footprint by 20% without performance degradation
- Enabled secure multi-tenancy to protect sensitive data

After the experiment is complete, the experimental team takes on the task of sifting through the data to extract meaningful results to refine scientific theory and also to define future experiments. Large compute clusters work around the clock to support the nonstop needs of the scientific teams that are composed of experts from across the world.

"NIF is an extremely valuable resource," says Bruno van Wonterghem, operations manager for NIF. "Our users in government laboratories and universities across the world are demanding more experiments from NIF. More experiments can only be achieved by having more uptime, greater availability, and shorter cycles."

"By having a cloud with essentially infinitely scalable storage, we can achieve our goal of supporting nonstop science for our nation."

Tim Frazier
Chief Information Officer
NIF

Star Power

With a private cloud based on NetApp running clustered Data ONTAP, NIF has reduced planned and unplanned downtime, reclaiming up to 60 hours of downtime per year for science and preventing costly delays. "We're a unique facility, so if there's a problem, we delay schedules that were made years in advance. Clustered Data ONTAP gives us the ability to add compute capacity for scientists when they need it and work on portions of our infrastructure without any disruption to workload," says Frazier.

As a global center for scientific collaboration, NIF depends on the highest levels of data security in its cloud environment. The secure multi-tenancy features of clustered Data ONTAP allow the NIF team to partition and protect sensitive data for users such as the U.S. Department of Energy, the world's most prestigious universities and laboratories, and scientists in the pursuit of the Nobel Prize. "By having a cloud with essentially infinitely scalable storage, we can achieve our goal of supporting nonstop science for our nation," says Frazier.

The combination of server and storage virtualization also has enabled NIF to make the most of its data center space while maintaining the performance required to support real-time analysis of experimental data. "By virtualizing," says Frazier, "we not only eliminated a data center, but also added almost 600 machines that now do useful computational tasks for the scientists."

To address performance challenges posed by the rapid proliferation of virtual machines, NIF combined clustered Data ONTAP with the strategic use of NetApp flash technologies to reduce latency by 97%, even as it grew its virtual footprint by 20%.

As a result, data can be available to scientists within 15 minutes after an experiment. "Those 15 minutes are incredibly exciting," explains Ma. "You have 20, 30 physicists who have stayed up all night because they're equally as excited, and we're all in front of our computers hitting the refresh button waiting for that data to pop up."

Laser Focus

The performance and reliability of its IT infrastructure are enabling NIF to operate at the speed of light in pursuit of discoveries that will enhance national security and also increase our knowledge of the universe and solve some of the world's most critical challenges. As NIF continues to pursue the goal of creating controlled thermonuclear ignition in a laboratory, scientists aren't the only ones getting excited.

"For me, it's all about working on something that can make a difference to our nation and also our civilization—on a global scale," says Frazier. "NetApp has been a part of the NIF story since the beginning and understands the importance of our mission."

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