National Ignition Facility at Lawrence Livermore National Laboratory Drives Energy Research with NetApp

KEY HIGHLIGHTS

Industry
Government

The Challenge
Deliver optimized access to scientific applications while providing high availability for storage capturing data from scientific instrumentation.

The Solution
Migrate to NetApp® clustered Data ONTAP® and use NetApp Flash Pool™ to accelerate performance for Oracle® virtual machines.

Benefits
- Accommodate scientific experiments 24/7, accelerating time to discovery
- Establish a global namespace for seamless workload mobility
- Eliminate up to 60 hours of planned downtime annually, maximizing facility availability
- Meet throughput requirements efficiently with strategic use of flash storage

Customer Profile

The National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is home to the world's largest laser—over 100 times more energetic than any previous laser system. Scientists at the Livermore, California facility are working on improving our national security, understanding the universe, and developing the science for providing renewable energy sources for the future.

The High Energy Density and Inertial Confinement Fusion physics teams have been making significant progress conducting experiments for the Stockpile Stewardship Program, including some experiments that seek to achieve the production of more energy than is required to initiate the process, also known as ignition. The futuristic-looking facility was also recently used as a set for the movie *Star Trek Into Darkness*. Experiments conducted at NIF could solve some of the most critical problems of our time.

The Challenge
Maximizing the value of facility time

Due to the size, nature, and criticality of its research, NIF must avoid system downtime whenever practical. Each time the laser is fired at a target, nonrelational object data produced by scientific instruments (about 50TB per year) is captured in files on network-attached storage, which must be accessible 24/7 for physicists to analyze. Algorithms then generate representations of the x-rays, plasmas, and other scientific phenomena that are stored as relational data in Oracle databases.

Like many facilities, the IT team at NIF uses scheduled maintenance windows to perform tasks such as the movement of data and reallocation of volumes. "We wanted to implement technology that did not require us to use downtime for storage management activities," says Tim Frazier, CIO at NIF and Photon Sciences Principal Associate Directorate for Lawrence Livermore National Laboratory. "We manage one of the biggest science facilities that our country is running. One of our Program's main goals is to continually improve facility availability and operational efficiency. This translates to a priority for IT to continue to find ways to improve the uptime and availability of the computing environment for our scientists. After all, the laser at NIF is the most energetic in the world, but our research is dependent on

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the infrastructure that enables our Program to use it for science."

Improving performance for virtual machines

To make the most of its data center space, NIF virtualized most of its Linux®-based application servers with Oracle VM Server. However, the IT team was concerned about the resulting load putting a strain on the facility's storage, especially when automated monitoring agents began collecting data.

"In our test lab environment, we saw latencies of more than two seconds when the agents became active," says Frazier. "If we had deployed to our production environments, we knew that systems would become unresponsive and that, in some cases, it might disrupt work until the monitoring process was completed."

The Solution
A global namespace for seamless workload mobility

NIF retired most of its legacy storage and deployed NetApp FAS3250 and FAS3220 storage systems running the clustered Data ONTAP operating system for nondisruptive operations. An eight-node NetApp cluster stores the virtual machine operating system images, while a four-node NetApp cluster stores scientific data in Hierarchical Data Format (HDF) to be ingested to Oracle SecureFiles. The 800 Linux virtual

machines connect to the NetApp cluster over a 10GbE network using the NFS protocol.

NetApp Professional Services performed the clustered Data ONTAP Migration Service, designed to help customers transition with minimal disruption. "NetApp Professional Services helped us migrate our data and decommission the older systems," says Frazier.

Having a unified cluster architecture such as clustered Data ONTAP is valuable to organizations like NIF that must maintain constant availability for large amounts of data. All of the NetApp storage systems can be managed as a single logical pool that can seamlessly scale to tens of petabytes and thousands of volumes. "Having a global namespace means we can move workloads around without losing the NFS file providers, a huge win for a 24/7 research facility like NIF," says Frazier.

NetApp block-level deduplication helps NIF make the most of its storage space, reclaiming an average of 40% of capacity for data volumes and up to 80% for virtual machine images.

NetApp Flash Pool improves storage I/O

To address the performance issues with virtual machines, NIF deployed NetApp Flash Pool to enable automated storage tiering in the NetApp Virtual Storage

Tier. By combining solid state disk (SSD) technology and hard disk (HDD) technology at the aggregate level, Flash Pool improves performance while minimizing cost, space, and power requirements. Flash Pool provides RAID-protected SSD storage, which is important for write-intensive applications. The technology uses a small amount of SSD very efficiently and is able to pick out the individual "hot" data blocks in real time. It also delivers data persistence because the SSD cache stays hot during high-availability (HA) failover events.

"We use NetApp Flash Pool to help us meet the IOPS and throughput requirements that the Oracle virtual machines create when analyzing scientific data, while keeping our storage and power footprint manageable," Frazier says.

Flash Pool is a base capability and does not require any additional software licensing from NetApp. Because Flash Pool uses a lightweight caching approach that works in real time and in a data-driven fashion, it remains always on. Users are not required to set up complicated policies to define data movement between the tiers.

Simplified management and monitoring

The NetApp Storage System Plug-In for Oracle Enterprise Manager monitors the physical cluster members and also the
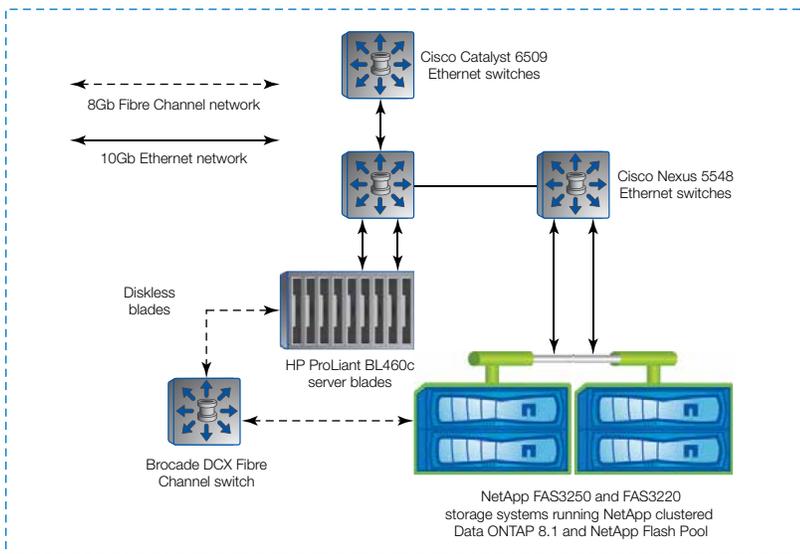
Figure 1) NIF clustered Data ONTAP storage infrastructure. A NetApp storage cluster with NetApp Flash Pool technology allows NIF to seamlessly move workloads without affecting scientific experiments.

performance of virtual servers. This convenient monitoring plug-in helps one systems administrator manage 600TB of NetApp storage capacity. "We can't afford to depend on storage technology that requires a lot of management and maintenance," says Frazier. "Our Program's focus is applied fusion science, not experimental computer science, and we need to make the most of our operating budget."

Using a clustered Data ONTAP feature called storage virtual machine (SVM), NIF is able to implement secure multi-tenancy in its virtual server and storage environment to provide cloud-based compute resources to sponsor organizations. The NIF team can create multiple virtualized storage controllers within a single physical NetApp storage system, enabling different users to share the same storage resource without compromising privacy or security.

"We're building a high-power, high–repetition rate laser here in Livermore that will be shipped to a lab that the European Union is starting," says Frazier. "We were able to dedicate a storage virtual machine to the project—basically carve off a piece of storage for them—without any inter-mingling of data."

NIF also uses NetApp Snapshot™ and SnapRestore® technologies to restore accidentally deleted or corrupted files in minutes, improving overall productivity.

"NetApp Snapshot copies are a critical tool for quickly recovering virtual machine images," says Frazier.

Business Benefits
Faster results accelerate fusion energy research

With clustered Data ONTAP, monthly maintenance outages for storage activities are no longer required, removing a temporary barrier between scientists and results. "Now when we need to do maintenance, we can just fail the workload over from one member of the cluster to another," says Frazier. "Our UNIX® system administrators don't even notice. When you consider the amount of people time involved, and the value of that time to our facility, reclaiming up to five hours a month from planned downtime is worth a lot to us, our sponsors, and the country. We don't anticipate needing outages for storage anymore, and that's 60 hours a year we can give back to science."

Reducing latency by 97% with automated storage tiering

Using NetApp Flash Pool helped NIF reach more than 27,000 peak input/output operations per second (IOPS) in its production storage environment, with peak write performance of 300MB/sec and peak read performance of 1000MB/sec. Latency has been reduced to acceptable levels, even when monitoring agents kick in. "We

can be assured that monitoring agents will work seamlessly in the background without the risk of causing us to pause experiments," Frazier confirms. "We're always under 500ms now, even under heavy load. That represents up to a 97% reduction in peak latency."

Partnering for the future of big science

The increased availability and through-put are allowing the scientists at NIF to depend on their IT infrastructure with less downtime, improving time to science and hastening breakthroughs that have the potential to change life as we know it—such as creating energy from seawater instead of burning fossil fuels.

"Our achievements represent the contributions of our operations and scientific staff as well as our technology partners," says Frazier. "Big science is done by smart people, but our success also depends upon having strong part-nerships with innovative and committed technology providers."

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SOLUTION COMPONENTS

NetApp Products

NetApp FAS3250 and FAS3220 storage systems

NetApp Clustered Data ONTAP 8.1

NetApp Flash Pool

NetApp Snapshot and SnapRestore technologies

NetApp deduplication

NetApp Storage System Plug-In for Oracle Enterprise Manager

Environment

Applications: Oracle Enterprise Manager, Oracle WebLogic, Glovia ERP system, Infor EAM, custom analysis and visualization applications, and instrument calibration and maintenance software Database: Oracle 11*g*

Server platform: HP ProLiant BL460c server blades

Network: Cisco® Catalyst® 6509 and Cisco Nexus® 5548 Ethernet switches; Brocade DCX Fibre Channel switch

Virtualization: Oracle VM Server

Protocols

NFS

CIFS

Fibre Channel

NetApp Global Services

NetApp SupportEdge Premium

Clustered Data ONTAP Migration Service

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