

Solution Brief:

Application Performance for Oil and Gas Seismic Analysis

Leveraging the strengths of seismic analysis applications with high performance scale-out file serving in data storage modules

Overview

The collection and analysis of seismic data requires robust and scalable processing and storage to provide analysis and reporting to a broad range of users including geologists, geophysicists, and field personnel. New techniques in marine seismic acquisition and analysis (3D, 4C and 4D), along with evolving seismic technologies such as Time Lapse, Wide Azimuth and Full Azimuth data acquisition are responsible for a sharp increase in the quantity of data that must be stored and processed. Data storage systems must adapt to this dynamic landscape by offering solutions that provide density, scalability and performance, and yet are simple to manage and affordable.

Dot Hill Systems, Intel and Mellanox have partnered to offer a solution to provide a highly scalable and high performance infrastructure for oil exploration computing platforms.

Key Applications

- Seismic interpretation
- Reservoir characterization
- Prospect evaluation systems
- Petrophysical analysis

The Challenge

Speed - When storage needs to be accessed by many computing nodes, such as in large analytical environments with interpretation and characterization of geospatial information, it is important that the storage subsystem delivers superior performance in order to enable the system as a whole to deliver results in a timely manner. Typical workloads involve many nodes or threads performing sequential access of very large files. While the workload of the individual node or thread is sequential in nature, the composite workload of many nodes or threads causes the underlying access pattern to become highly randomized. The storage subsystem needs to respond to this environment by maintaining high sequential throughput as the number of simultaneous streams increases.



Capacity – Geophysical data consumes tremendous amounts of storage capacity. Typical systems require hundreds of terabytes and even petabytes of storage which needs to be readily accessible for long periods of time. These requirements drive the need for storage solutions that provide high capacity, high density, low cost and low overhead.

Scale –To achieve greater speed and capacity, storage systems can either scale up, or scale out. It is understood that scale up architectures are ultimately limited by the monolithic design of the system. On the other hand, scale out architectures offer much more opportunity to scale both capacity and performance.

Namespace –The objective of any storage subsystem is to have a global namespace to access all storage from. This greatly simplifies the management of the storage, since there is no need to manually balance and manage data among multiple storage namespaces.

The Solution

The Dot Hill Scale-Out, High Performance File Serving solution consists of hardware components, software elements and infrastructure, architected to provide balance and scalability. This means that the components of the architecture have been sized and selected to match the other components and that the solution is designed with growth in mind. Customers can begin by deploying a modest implementation, and then easily add modules as their needs expand.

Storage. The backbone of the solution is the AssuredSAN 4004 Storage Array. This workhorse includes many key features that allow it to deliver high performance and reliability. Adaptive caching technologies are employed to accommodate dozens of independent streams of data without degrading overall throughput. This is a critical feature for applications that depend upon reliable, high performance data streaming. In addition, the proven 99.999% availability of AssuredSAN products virtually eliminates downtime, allowing the datacenter to operate smoothly. Individual arrays support up to 96 Large Form Factor (LFF) disk drives. Using 4TB 7K SAS disk drives, a single system can provide 384TB of raw capacity.

File Serving. The Intel® Enterprise Edition for Lustre software provides the high performance distributed file system and namespace component of the solution. Lustre is an increasingly popular solution in High Performance Computing environments because it enables bandwidth, performance and scaling well beyond the limits of traditional storage technology. In fact, Lustre is the file system that is most widely used by the world's top 500 supercomputing sites. The Lustre architecture consists of Object Storage Servers (OSS), Metadata Controller Servers (MDS) and client nodes connected over a high speed network. Lustre offers highly scalable network connectivity to the Lustre clients, with higher per-stream performance than that of NFS or CIFS. The Intel Enterprise Edition for Lustre software includes a rich set of manageability components designed to simplify many tasks associated with configuring, deploying, tuning, managing and maintaining Lustre.

Networking. Mellanox is an industry leader in providing high speed networking components and infrastructure. To realize the benefits of high performance storage subsystems, it is important to couple them with a high speed network to the end clients. Mellanox InfiniBand solutions support the FDR 56Gb rate, which is the highest throughput and lowest latency interconnect available on the market today. In addition, Mellanox network solutions utilize Remote Direct Memory Access (RDMA) protocols to make more efficient use of compute resources. Using RDMA over InfiniBand, data transfer latencies can be reduced by over 90% and CPU efficiencies can be elevated up to 96%.

Architecture. The solution comes together as described in Figure 1.

- **Storage Modules.** One or more Storage Modules form the basis of the data repository. Each module consists of a Dot Hill AssuredSAN array and two industry standard x64 servers. The servers are connected to the array with common 12Gbit SAS interconnects, and connect to the file serving network via high speed InfiniBand. These servers host Linux as the OS and the Intel Lustre File Server (OSS) component. Each server pair is clustered together for high availability.

- **Metadata Module.** One Metadata Module is required to provide the necessary file locking and file integrity of the distributed environment. This module consists of a pair of clustered servers, loaded with Linux and the Intel Lustre Metadata (MDS) component. The servers connect to a dedicated AssuredSAN array via SAS interconnects, and to the file serving network via high speed InfiniBand.
- **Client Connectivity.** The client nodes in the network host the end user applications that process the data. These nodes include client software for Lustre file serving, and connect to the network via high speed InfiniBand.
- **Networking.** InfiniBand switches and HBAs complete the solution. This infrastructure is necessary to provide the high bandwidth streaming required in many HPC solutions in general, and seismic analysis and processing within the Energy Industry in particular.

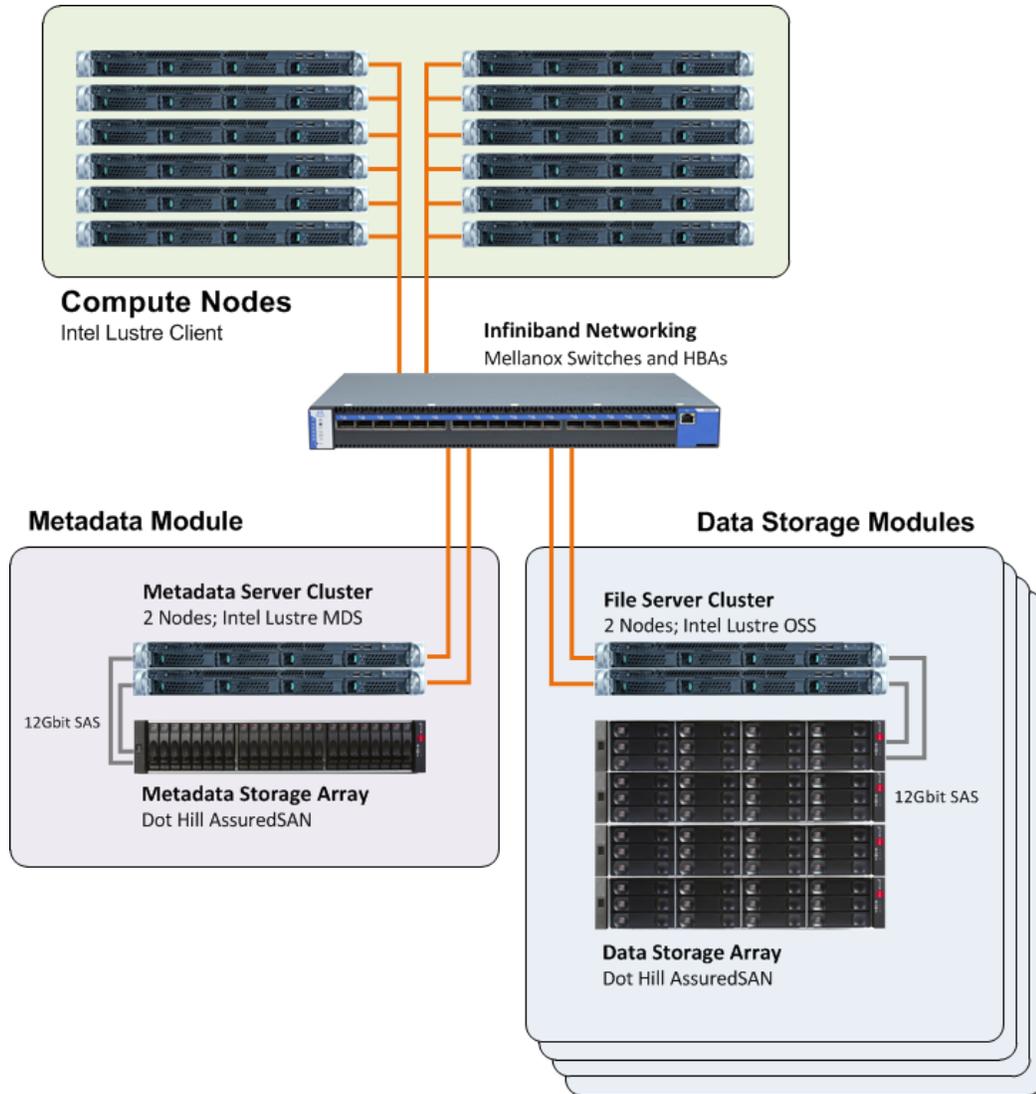


Figure 1

High Performance Scale-out Storage for Seismic Analysis

Solution Benefits

- Availability. Redundant Fail-over components provide high availability of storage subsystem.
- Protection. Enterprise class components and drives, along with RAID technology protect valuable data sets
- Scalability. Add Storage Modules as needed to expand to 10s of petabytes.
- Performance. Individual Storage Modules offer 6 GB/s throughput, scaled linearly with added modules. InfiniBand network paths can deliver up to 56Gbit throughput to each compute node.
- Neutrality. Avoid vendor lock-in by deploying Open Source solutions.
- Manageability. The Intel Enterprise Edition for Lustre software includes a rich set of management tools.
- Namespace. The unified namespace offered by Lustre eliminates the need to micromanage storage pools.
- Capacity. Each individual Storage Module can be configured with as much as 384 TB of raw capacity. Scale-out the solution with multiple Storage Modules to obtain Petabytes of usable capacity.

Solution Components

- Dot Hill AssuredSAN 4534 SAS RAID Storage Arrays for primary data
- Dot Hill AssuredSAN 4524 SAS RAID Storage Array for Metadata
- LSI SAS9300-8e SAS HBAs
- Industry Standard x64 Servers for File Serving and Metadata
- Enterprise Linux
- Intel Enterprise Edition for Lustre software
- Mellanox ConnectX-3 InfiniBand HBAs
- Mellanox InfiniBand Switches

About Dot Hill Systems

Dot Hill has been delivering smart, simple, storage solutions for 29 years and has shipped over 600,000 units world-wide. Dot Hill's solutions combine a flexible and extensive hardware platform with an easy to use management interface to deliver highly available and scalable SAN solutions. AssuredSAN™ arrays provide a high performance storage solution ideal for large datasets and multiple compute nodes common to the oil and gas exploration industry. The AssuredSAN 4004 features 12Gb SAS host connections, 99.999% availability, and scale up to 384 terabytes in a single array. Visit Dot Hill at www.dothill.com and our partner portal at partners.dothill.com.

About Intel

Intel (NASDAQ: INTC) is a world leader in computing innovation. The company designs and builds the essential technologies that serve as the foundation for the world's computing devices. Visit Intel at lustre.intel.com.

About Mellanox Technologies

Mellanox Technologies is a leading supplier of end-to-end InfiniBand and Ethernet interconnect solutions and services for servers and storage. Mellanox interconnect solutions increase data center efficiency by providing the highest throughput and lowest latency, delivering data faster to applications and unlocking system performance capability. Mellanox offers a choice of fast interconnect products: adapters, switches, software, cables and silicon that accelerate application runtime and maximize business results for a wide range of markets including high performance computing, enterprise data centers, Web 2.0, cloud, storage and financial services. Visit Mellanox at www.mellanox.com.