Introduction to Intel® Solutions for Lustre* Software

Module Objectives

At the end of this course you will be able to:

- Define what the Lustre* file system is
- List the major characteristics of the Lustre* file system
- Identify the basic components of the Lustre* file system architecture
- Identify the differences between traditional network file systems and a Lustre* file system
- List the three Lustre*-based software solutions developed and offered by Intel
- Identify the features and technology that Intel adds to the Lustre* file system

Module Overview

High-level Lustre* overview

- What is Lustre*?
- Characteristics of Lustre*
- Key markets for Lustre*
- Advantages of Lustre*
- Lustre* architecture
- Typical Lustre* I/O
- Traditional network file systems versus Lustre*

Intel® Solutions for Lustre* Software

- Open source products
- Lustre* enhancements from Intel

High-level Lustre* Overview

What is Lustre*?

- Object based, distributed, parallel, clustered file system
- Accessed by clients over network (Ethernet, InfiniBand)
  - Up to 512 PB file system size, 32 PB per file
  - Production file systems have I/O rates in excess of 1.2TB/sec
- Open source and Linux-based - largest install bases are on RHEL* / CentOS* and SLES*
- Also provides storage for other Operating Systems - Windows and OS X using a gateway server such as NFS or CIFS
- Foundation in traditional High Performance Computing (HPC) - still core business
  - Excels in sequential, large block parallel I/O from multiple clients
- Now getting established in data centers of non-traditional HPC
  - Data centers with large data sets and high availability needs

Lustre* Characteristics

Open Source (GPL v2)
- Anyone can obtain the source code
- Compliance to Open Source License terms and conditions

Scalable
- Start small - add more components
- Performance scales - almost linearly

Distributed
- File system distributed across many arrays
- Allows for large scale solutions

Parallel
- I/O with multiple storage targets simultaneously
- Client bandwidth increases

Clustered
- High availability for most components
- If one component fails, another picks up the load

High Performance
- Measured in aggregate throughput
- Workload is distributed equally servers

POSIX* Compliant
- No need to rewrite applications
- Drop in and run

Resource Efficient
- Nodes can withstand intense workloads
- Customers are not forced to “buy more”

Cost Effective
- Commodity hardware and open source software
- Considering support, Lustre* compares well

Global, shared namespace
- Everything looks like one big file system
- All clients can access all data in parallel

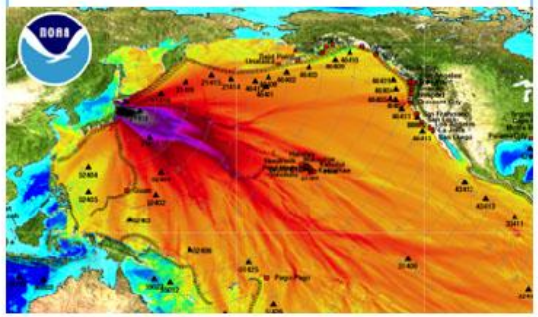
Key Markets Using Lustre* Today

Bioscience
Genomic data analysis, modeling and simulations

Government
Research and defense

Large-scale manufacturing
Mechanical computer-aided design & computer-aided engineering systems

Weather and Climate
Highly complex CGI rendering



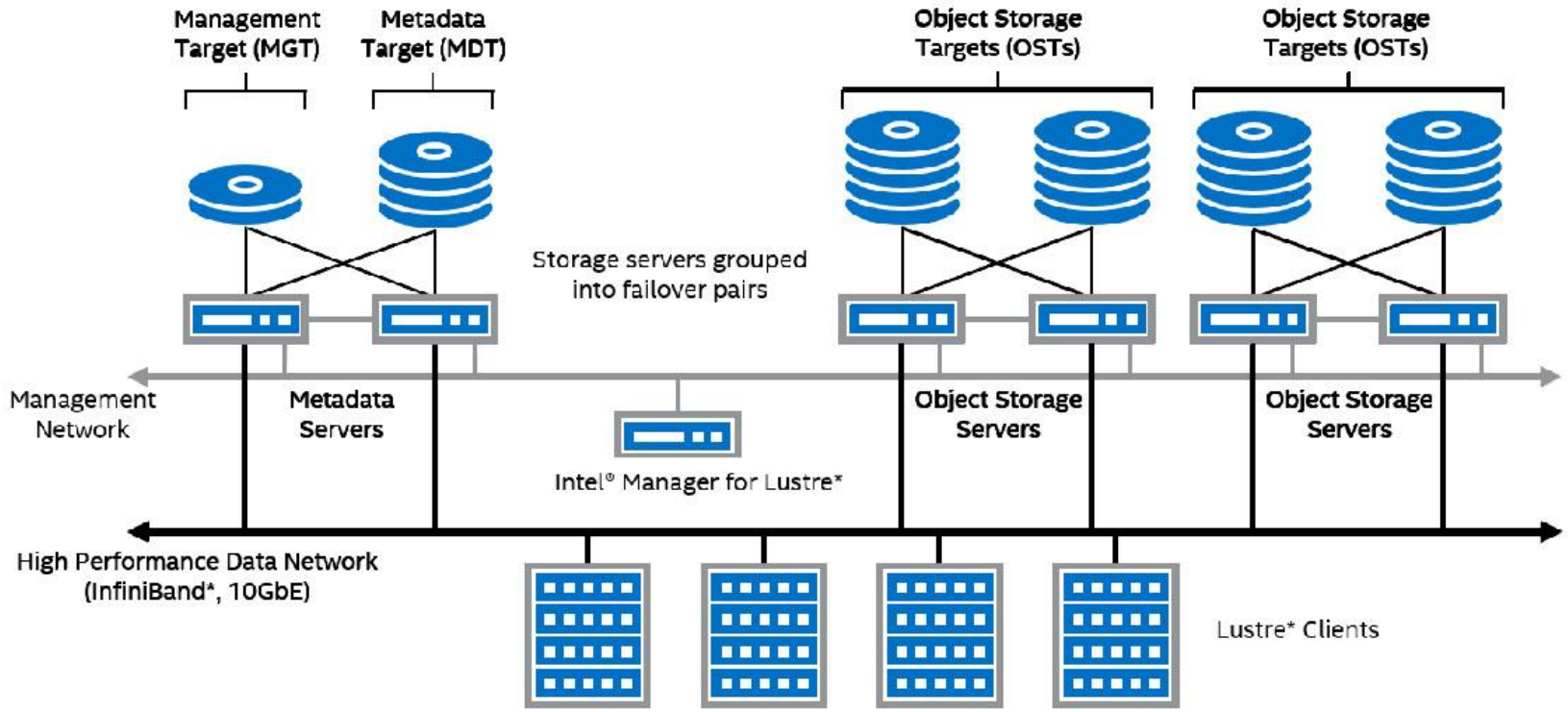
Energy
Seismic processing, reservoir modeling / characterization, sensor data analysis

Finance
Fraud detection, Monte Carlo simulations, risk management analysis

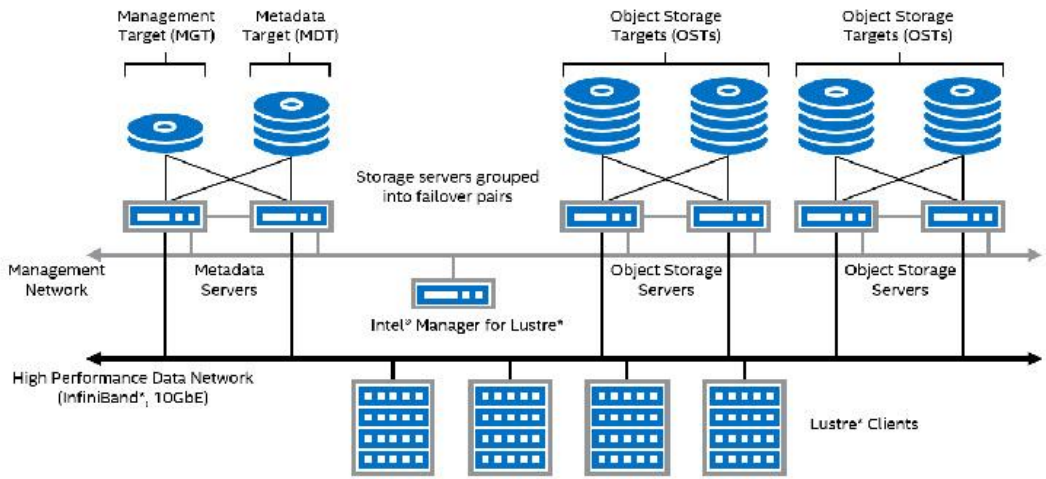
Lustre* Advantages

- Speed: Excellent performance, especially large block sequential I/O
- Open platform: Intel® Xeon® servers and leading Linux distributions
- Efficiency: Can achieve 90+% utilization of storage and network hardware
- Storage choice: Storage hardware neutral, broad array of block storage partners
- Affordability: Low CAPEX and OPEX
- Scalability: Independently scale storage capacity and bandwidth ("build up" and/or "build out")
- Stability and reliability: Backed by Intel, the worldwide leader in Lustre* support

Lustre* Architecture - What Does a Lustre* Solution Look Like?

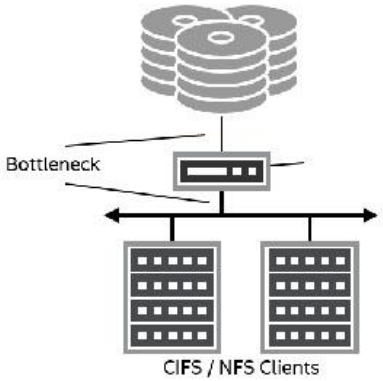


Typical I/O



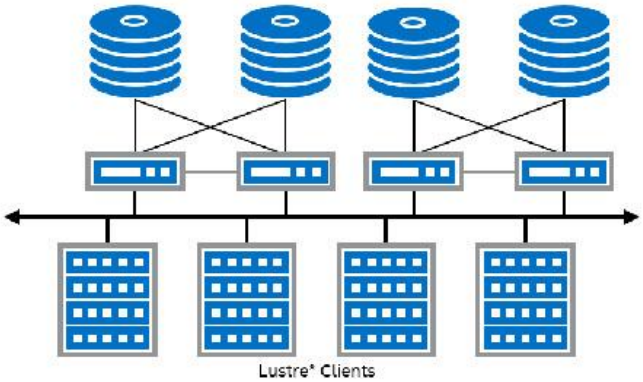
- Different targets for metadata and block data
- Backend file system on targets to store data
- Client applications see namespace as single POSIX* file system
- Targets exported to clients via the Lustre* network
- Lustre* uses a Client / Servers design

Traditional Network File Systems vs Lustre*



Distributed client, central server, e.g. NFS, CIFS/SMB

- Network performance and scalability limited by single server bandwidth
- Scalability limited by physical constraints of server and array
- New storage server creates a separate file system
- Storage becomes fragmented into silos



Distributed client, distributed servers (Lustre*)

- Scale performance and capacity linearly as clients grows
- Client network scalability is not limited by the file system
- All clients can access all storage servers simultaneously and in parallel
- Single coherent namespace across all servers
- Hundreds of network storage servers in a single file system

Intel® Solutions for Lustre*

What Intel Adds to Lustre*

- Manpower dedicated to software development
- Releases and features beyond the Community Lustre* release
- Infrastructure/technology for better software testing and development
- Industry leading Lustre* experience and support

What Intel Adds to Lustre* – Manpower

- Intel - 4th largest software development company in the world
- More than 10,000 developers at over 35 sites
- Largest team of Lustre* software developers and engineers in the world
- Most contributions to Lustre* code
- Commitment to development of Linux kernel and compilers

Intel® Solutions for Lustre*

Intel® Enterprise Edition for Lustre* Software

High performance, petascale storage platform, ready for business

Intel® Foundation Edition for Lustre* Software

The newest features, the latest technology

Intel® Cloud Edition for Lustre* Software

Scalable, parallel storage performance on demand, available today on Amazon Web Services

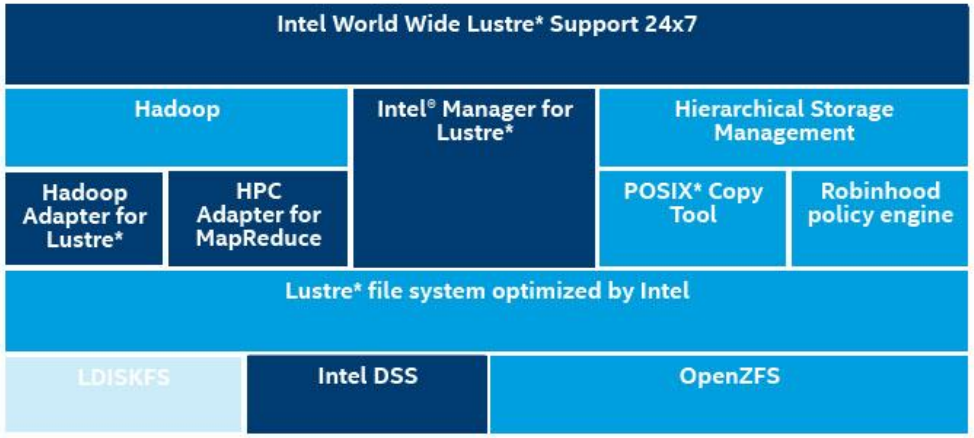
* All three editions are supported by Intel.

Intel® Enterprise Edition for Lustre* Software

Key Features

- Production quality Lustre* file system, enhanced by Intel
- Intel® Manager for Lustre* (IML) software
- Intel Lustre* adapter for Apache Hadoop and Cloudera Hadoop
- HSM support, including POSIX* copy tool and a powerful policy engine
- Maximum data protection using ZFS
- Improved small file performance using DSS
- 24x7 Enterprise support
- Xeon Phi client optimization

Intel® EE for Lustre* Software & Support Stack



Intel® Foundation Edition for Lustre* Software: Fusing Innovation with Support

Key Features

- Community Lustre* software base, with additional open source code from Intel
- Maximum configuration size and scale
- Flexible deployment architectures
- Global technical support expertise

- Customers: Technically strong end-users and OEMs looking for the latest features and maximum flexibility
- Key Markets: HPC markets – large scale research, top500 supercomputing
- Key Benefits: Targeted at customers with Lustre* experience seeking the latest releases, unusual deployment architectures, extreme scale, or in-house development on top of Lustre

Intel® Cloud Edition for Lustre* Software: Parallel Storage for Unparalleled Results

Key Features

- Storage performance and scalability boost app performance
- Compliant with key industry standards
- Broad AWS* compute instance support
- AWS* Elastic Block Storage or ephemeral storage
- Global technical support expertise from Intel

Current Status

- Available today on Amazon Web Services Marketplace and Azure

- Customers: End-users or cloud infrastructure providers wanting superior storage performance
- Key Markets: HPC moving onto cloud, emerging applications deployed to cloud infrastructure
- Key Benefits: I/O and capacity of parallel, distributed storage for cloud-based workloads; cost effective and productive; runs larger, more complex simulations and models with minimal risk or cost impact

Lustre*, by Itself, Does Not Make the Storage Solution

How do you create a high performance, reliable Lustre* storage system?

Whatever you need, from designing a solution to debugging Lustre*, Intel is there.

How can you tell what is happening in your Lustre* file system?

When you get a call saying "the file system is running slow" or asking "is everything ok with Lustre?*", what do you do? Intel has an app for that.

Who can give 24x7, world wide support for Lustre* on your preferred hardware?

When you have problems with the file system, Intel is there.

Where do you start when tuning your Lustre* file system?

When you need in depth knowledge tuning Lustre* for your applications, Intel is there.

How can you have the most reliable version of Lustre* with the best possible support?

Intel's Lustre* software goes through extensive testing and bug fixes, adding reliability and stability, and includes Intel's world class support.

What Intel Adds to Lustre* – Technology

Intel's Infrastructure and Technology for better software

- Proven quality assurance for all Lustre* and Intel® Enterprise Edition for Lustre* Software releases
- Close partnership with community to drive new features
  - Management and hosting of issue ticketing system for both Intel customers and open source community
- Intel manages the delivery of all new code including features and maintenance

What YOU Add to Lustre*

- First line of support for your customer
- Interface between your customer and Intel
- Improve customer satisfaction with Lustre*
- Improve Lustre* quality
- Educate your customer on Lustre*

Summary

- What is Lustre*?
  - Object based, distributed, parallel, clustered file system
  - Open source and Linux-based
- Lustre* Characteristics
  - Scalable, POSIX* compliant, resource efficient, and cost effective
- Key Markets Using Lustre* Today
  - Bioscience, government, large-scale manufacturing, weather and climate, energy, and finance
- Lustre* Advantages
  - Speed, open platform, efficiency, storage, affordability, scalability, stability and reliability
- Architecture
  - Client(s), Metadata services, Object Storage services and Networking

Summary (cont.)

- Typical I/O
  - Uses Client / Servers design
  - Applications see single namespace and access storage targets indirectly
- Traditional Network File Systems vs Lustre*
  - No bottleneck with scalability
  - 90+% utilization of storage and network hardware
- Largest team of Lustre* software developers and engineers in the world
- Support from the people who bring you Lustre*

Summary (cont.)

Intel® Enterprise Edition for Lustre* Software

- Production quality Lustre* file system
- Intel® Manager for Lustre*

Intel® Foundation Edition for Lustre* Software

- Community Lustre* software base
- Flexible deployment architectures

Intel® Cloud Edition for Lustre* Software

- Excellent storage performance and scalability
- Global technical support expertise from Intel

- What Intel adds to Lustre* – Technology
  - Infrastructure and technology to produce quality software
  - New features, driven by community
- What YOU add to Lustre*
  - First line of support to your customer
  - Interface between your customer and Intel

Congratulations! You have completed:

Introduction to Intel® Solutions for Lustre* Software