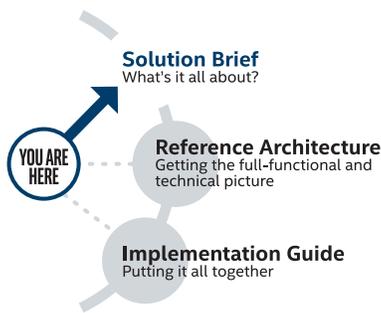




High-Performance Computing Speeds Discovery

Oil and gas companies gain competitive advantages with Intel® Scalable System Framework



Executive Summary

Data has been synonymous with the oil and gas industry for many years and has resulted in the use of new and expanded high-performance computing (HPC). Exploration and production companies use advanced analysis, simulation, and interactive high-fidelity visualization to identify oil and gas reserves, assess the economic viability of assets, and support operational designs that maximize output.

As long-time users of advanced technologies, oil and gas companies extract valuable information from huge amounts of seismic data. To gain the full value of this data, companies need HPC systems that can process data quickly, with efficient use of processor clusters.

The challenges of managing increasing amounts of data with higher compute requirements, along with tough industry competition, can put companies at a competitive disadvantage.

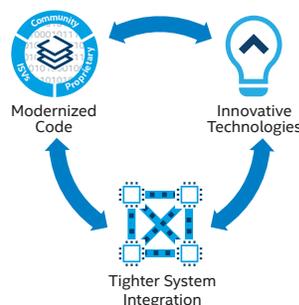
Intel® Scalable System Framework (Intel® SSF) for HPC combines highly scalable processing, powerful workstations, and modernized software code to create a holistic solution to these challenges. With Intel SSF, oil and gas companies can make better-informed decisions and gain a competitive advantage.

“Our solutions, powered by Intel® Xeon Phi™ processors, enable interactive processing and imaging from each of our geophysicists’ individual computers. A testing regime that once took weeks to months now takes days.”¹

—Dr. Matt Lamont
DownUnder GeoSolutions
Managing Director

Intel Solution Architects
Herbert Cornelius
Principal HPC Solutions Architect
Influencer Sales Group
Anna Scott
Oil and Gas Solutions Architect
Influencer Sales Group

Intel® Scalable System Framework



Benefits of a Holistic Solution

- Greater Detailed Analysis
- Reservoir Simulations
- Interactive Visualization
- Shorter Compute Times

Figure 1. A holistic approach that includes Intel® Scalable System Framework is necessary to fully realize the benefits of high-performance computing.

Benefits

Intel® SSF uses highly scalable processing, powerful workstations, and modernized software code to create a high-performance computing solution with the following benefits:

- **Greater detailed analysis.** Process large amounts of seismic data more quickly.
- **Reservoir simulations.** Get more realistic simulations with new imaging algorithms.
- **Interactive visualization.** Run interactive visualization on workstations.
- **Shorter compute times.** Reduce time to results from weeks and months down to days.

Business Challenge: Compute Capabilities Determine Competitive Edge

To improve the exploration methods and optimize the production of gas and oil, geophysicists, geologists, and engineers use advanced data analytics, simulations, and interactive high-fidelity visualization to process seismic data and run reservoir simulations necessary for accurate drilling. These methods are also used to improve quality and yield rates on existing wells. Challenges include storing and managing ever-increasing amounts of data with higher fidelity requirements, including interactive processing and visualization for modeling complex oil and gas fields. Tough competition in the energy sector, coupled with shorter turnaround times and tighter development and operations budgets, can put companies at a competitive disadvantage if they lack fully optimized high-performance computing (HPC) capabilities.

For decades, HPC has been a vital resource for discovery and innovation, providing new insights in science, engineering, and business. HPC solutions with advanced Intel® technologies have given oil and gas companies the tools to address the issues of increased data and industry competition. However, a holistic solution is needed to fully realize the benefits of HPC—one that includes powerful compute technologies, tighter integration, and modernized code.

HPC Speeds Gas and Oil Exploration and Discovery

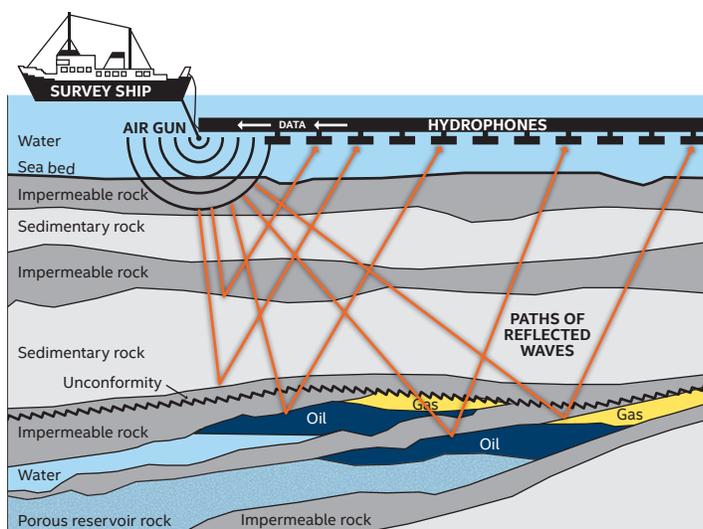
To stay competitive, energy companies aim for rapid geophysics exploration and discovery, leading to efficient extraction of recoverable oil and sustainable management of natural gas reserves. HPC can help energy companies gain new insights faster and at lower costs, facilitating better decision making and greater competitive advantages.

HPC is Practical, Cost Effective, and Efficient

Once seismic data is acquired from the field (see Figure 2), HPC can address the following areas:

- **Seismic processing.** Data processing for alteration of seismic data to suppress noise, enhance signal, and migrate seismic events to the proper location in space.
- **Reservoir simulation.** Combining physics, mathematics, reservoir engineering, and computer simulations helps to develop a procedure to model the behavior of a reservoir.
- **High-fidelity seismic data visualization.** Interactive 3D navigation makes working with very large simulation data sets and models easier.

To meet the requirements for computing in these areas, HPC solutions must be cost effective, practical for production use, and efficient. Modernizing software code and increasing integration and compute power offer new ways to meet these requirements.



Analysis of Data Using HPC



Seismic Processing



Reservoir Simulation



High-fidelity Seismic Data Visualization

Figure 2. Seismic data gathered in the field can be analyzed in greater detail, creating more accurate simulations and enhanced interactive visualization in the HPC environment.²

CGG Improves Its HPC Performance Four-fold

Compagnie Générale de Géophysique (CGG) enhanced its HPC capabilities in order to improve the performance of its seismic processing and imaging models. CGG's geophysicists and geologists needed to process and analyze growing data volumes produced by advances in seismic data-acquisition techniques. They also wanted to satisfy customer demands for greater accuracy and speed while controlling the cost of producing seismic analysis. With high-performance parallel processing powered by Intel® Xeon® processors and Intel® Xeon Phi™ processors, as well as Intel® Solid State Drives (SSDs) for enhanced throughput, CGG has improved performance by approximately 400 percent.

CGG's HPC installation delivered resounding value, including:

- **Faster, more refined modelling.** CGG's proprietary, computationally intense application, Geovation*, can deliver more accurate sub-surface analysis to pinpoint economically viable oil or gas reserves.
- **Competitive position.** CGG significantly improved performance without increasing its costs to grow the business and help maintain a strong position in a competitive field.

CGG's HPC cluster is helping their clients identify potential oil and gas reservoirs, asses their economic viability, and design exploration and drilling operations that maximize output.

Solution Value: Faster Discovery with More Accurate Results

In the oil and gas industry, time is crucial. Integrated HPC solutions give companies the ability to do more, faster, and with better results. Scalable HPC solutions based on Intel technology can help companies implement a comprehensive infrastructure and workflows that improve processing, data handling, and visualization.

The benefits of Intel's cost-effective and flexible HPC solutions are based on the Intel® Scalable System Framework (SSF), which tightly integrates components with modernized software code (see Figure 3). The benefits include the following:

- **Greater detailed analysis.** Large amounts of seismic data can be processed more quickly.
- **Reservoir simulations.** Newer imaging algorithms provide more realistic simulations.
- **Interactive visualization.** Using HPC, interactive visualization can be run on workstations.
- **Shorter compute times.** HPC increases productivity, accelerating time to results from weeks or months to days.

Intel SSF for HPC solutions integrates easily with powerful workstations for 2D and 3D high-fidelity visualization of large simulation models. Interactive navigation makes working with very large simulation data sets and models much easier.

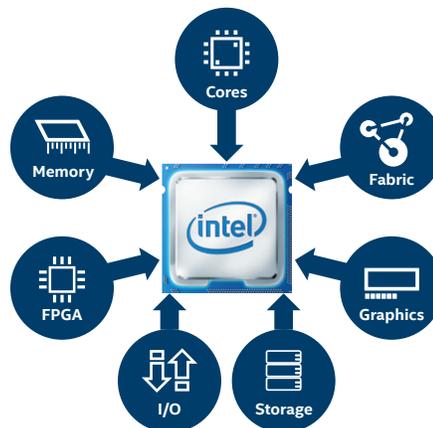


Figure 3. Tightly integrated memory, processors, fabric, graphics, field-programmable gate arrays, storage, and input/output with modernized software code return greater bandwidth and density with lower latency, power, and cost.

Solution Architecture: Intel Scalable System Framework

Intel SSF fully optimizes HPC capabilities with Intel technologies (see Figure 4), including:

- **Intel® Xeon® processor E5-2600 v4 product family.** Higher core counts, faster memory speeds, and improved performance-per-core with the Intel Xeon processor E5-2600 v4 product family.³
- **Intel® Xeon Phi™ product family.** Intel® Xeon Phi™ processors are designed to deliver extreme parallel performance for the most demanding HPC workloads. These Intel® processors, the first to use high bandwidth memory, integrate Intel® Omni-Path Architecture (Intel® OPA).
- **Intel Omni-Path Fabric.** Intel OPA can help balance overall system performance, which may reduce latency and minimize bottlenecks; it delivers the industry's most scalable and highest performance fabric.⁴
- **Intel® Enterprise Edition for Lustre* software.** Lustre parallel file system for HPC workloads is designed to help enable organizations to improve performance and scalability.⁵
- **Intel® SSD Data Center Family for NVMe.** NVMe technology and Intel® Optane™ technology-based SSDs can help deliver outstanding storage performance to withstand the toughest data center applications with the low latency and high efficiency of PCIe drives.
- **Intel® HPC Software Platform.** Intel's licensed and supported premium HPC system software products based on the OpenHPC project are improved with additional components and advanced testing.
- **Intel® Software Development Tools for HPC.** Intel software tools for HPC are a comprehensive set of advanced software development tools and optimized libraries that can help boost application performance on highly parallel processors. Intel technologies—including Intel® Node Manager, Intel® Parallel Studio, and Intel® Trace Analyzer—are designed to aid in cluster management and application development.

HPC System Built on the Intel® Scalable System Framework

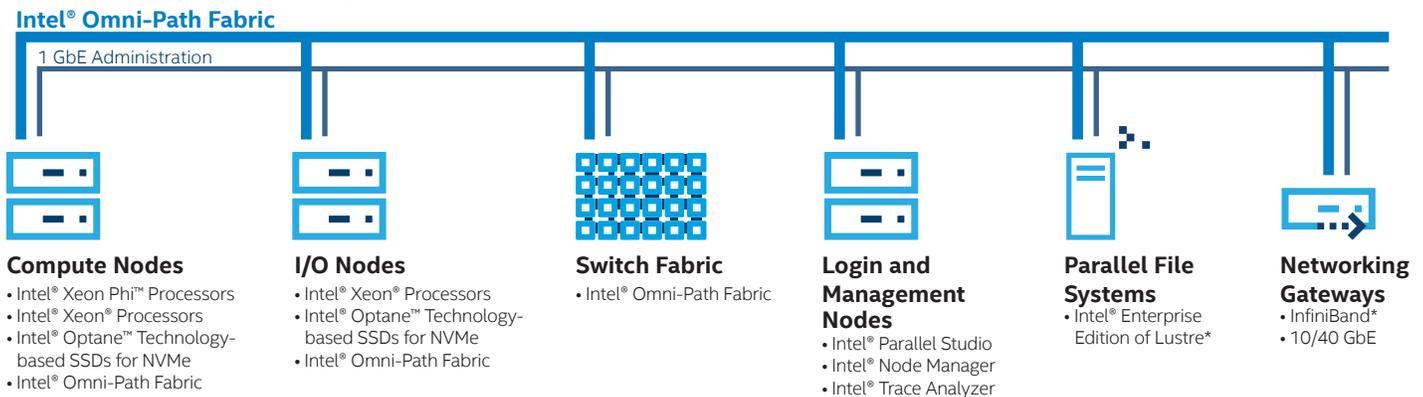


Figure 4. Intel® Scalable System Framework provides a foundation on which to build an entire HPC system.

Conclusion

Oil and gas companies face tough competition today, and rapid discovery and extraction is necessary to maintain a competitive edge. But with ever-increasing data volumes and compute requirements, it can be challenging to stay ahead.

Intel SSF for HPC solutions designed for advanced oil and gas exploration and production consist of highly scalable Intel Xeon and Intel Xeon Phi processor-based clusters and powerful workstations with optimized and comprehensive software environments. Intel SSF provides a powerful, cost-effective, and flexible infrastructure to conduct more detailed analysis, realistic simulations, and interactive high-fidelity visualization with shorter compute times.

With Intel SSF, companies can reduce operational costs while gaining more accurate insights, making better-informed decisions, and acting more quickly.

Find the solution that is right for your organization. Contact your Intel representative, register at [Intel IT Center](#), or visit intel.com/energy.



Learn More

The following resources may also be useful:

- **Compagnie Générale de Géophysique:** cgg.com
- **DownUnder GeoSolutions:** dugeo.com
- **HPC Gives Oil & Gas Companies a Competitive Edge:** insidehpc.com/2015/07/hpc-gives-oil-and-gas-a-companies-edge
- **Taking Oil and Gas Exploration to the Next Level Case Study with DownUnder GeoSolutions:** intel.com/content/www/us/en/high-performance-computing/dug-geosolutions-case-study.html
- **Intel High-Performance Computing:** intel.com/hpc
- **Intel Scalable System Framework:** intel.com/ssf
- **Intel® Parallel Studio XE:** software.intel.com/en-us/intel-parallel-studio-xe

Solutions Proven By Your Peers

Intel Solution Architects are technology experts who work with the world's largest and most successful companies to design business solutions that solve pressing business challenges. These solutions are based on real-world experience gathered from customers who have successfully tested, piloted, and/or deployed these solutions in specific business use cases. Solution architects and technology experts for this brief are listed on the front cover.

¹ Source: insidehpc.com/2014/10/sgl-xeon-phi-power-oil-gas-discovery

² Source: www.epa.gov/esd/cmb/GeophysicsWebsite/pages/reference/methods/Marine_Geophysical_Methods/Marine_Seismic_Methods.htm

³ For more information go to intel.com/content/www/us/en/benchmarks/server/xeon-e5-v4/xeon-e5-v4-world-record.html.

⁴ Number of switch chips required, switch density, and fabric scalability are based on a full bisectonal bandwidth Fat-Tree configuration, using a 48-port switch for Intel® Omni-Path Architecture and 36-port switch ASIC for either Mellanox or Intel® True Scale Fabric.

⁵ For more information go to intel.com/lustre.

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Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors.

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