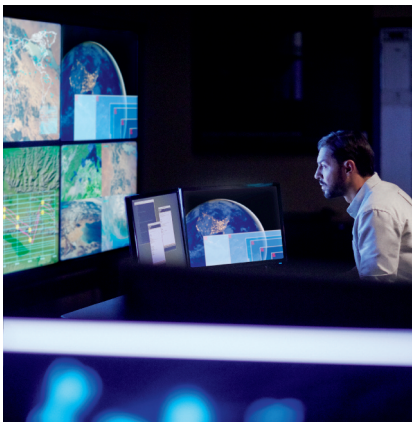
CASE STUDY

Improving the accuracy of CGG's seismic modeling for upstream oil and gas

Intel® Xeon Phi™ Product Family

High-Performance Computing



Passion for Geoscience

Geoscience company CGG is enhancing its high-performance computing (HPC) capabilities to enrich the performance of its seismic processing and imaging models. CGG is recompiling and optimizing the code for its most compute-intensive module on Intel® Xeon® processor E5 family and will port the code onto a future cluster powered by 2nd generation Intel® Xeon Phi™ product family. The HPC cluster will help CGG's clients to identify potential oil and gas reservoirs, assess their economic viability, and design exploration and drilling operations to maximize output.

Challenges

- **Advanced seismic techniques.** CGG's geophysicists and geologists needed to process and analyze growing data volumes produced by advances in seismic data acquisition techniques
- **Performance and price.** In a competitive field, CGG wanted to meet customer demands for greater accuracy and speed while controlling the cost of producing seismic analysis

Solutions

- **High-performance parallel processing.** CGG is extending its HPC cluster with custom-built server blades from 2CSRi, powered by the Intel® Xeon® processor E5 family and Intel® Xeon Phi™ processors
- **Enhanced throughput.** CGG has also added the Intel® Solid-State Drive (Intel® SSD) DC S3500 series to ensure that throughput capability matched the cluster's enhanced performance

Technology Results

- **Improved performance.** According to CGG's internal assessments, an Intel Xeon Phi coprocessor node is approximately four times faster than a node in the existing cluster based on the Intel Xeon processor E3 v3 family[1]
- **Easily ported application.** With support from Intel, CGG was able to optimize the code of its most compute-intensive applications and transfer it to its Intel Xeon Phi coprocessor

Business Value

- **Faster, more refined modeling.** 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

Parallel processing, high performance, and enhanced throughput help de-risk oil exploration and production

"We can take code optimized for our existing Intel® Xeon® processors and execute it in an HPC cluster with Intel® Xeon Phi™ coprocessors without re-architecting. It helps keep our development costs low and significantly reduces the risks associated with porting our complex and business-critical code to a new high-performance computing cluster."

Marc Tchiboukdjian, System Architect, CGG

Geoscience in the commercial world

Companies in the capital-intensive upstream operations of the global oil and gas industry need highly sophisticated geological and geophysical techniques to minimize the costs and risks associated with the exploration and production of new hydrocarbon reserves.

Headquartered in France and serving an international client base, CGG is a fully integrated geoscience company whose Geology, Geophysics and Reservoir (GGR) Division is a major provider of processing, imaging, and interpretation for geophysical and seismic data. CGG's global teams of geologists and geophysicists create highly accurate images of the Earth's onshore and offshore subsurface, helping clients to pinpoint the presence of essential natural resources.

Advanced algorithms for seismic imaging

Seismic processing and imaging is a computationally intensive process. Scientists at CGG use a variety of techniques to gather an array of data about the subsurface structure and geology of potential oil or gas reserves. Turning this raw data into meaningful intelligence requires a series of complex processing sequences and mathematical models, which reconstruct the shape and physical properties of the Earth's geological layers in two, three or four dimensions.

These seismic images enable CGG's clients to identify potential oil and gas reserves, detect the speed and direction of flow, and determine whether production is economically viable. Seismic imaging also helps CGG's clients select the most effective drilling techniques and wellbore distribution to maximize output from a given site. The more detailed the image, the more CGG can reduce exploration and production risks for its clients.

At CGG, seismic modeling and sequencing is performed by its proprietary application, Geovation, which brings together more than 450 separate batch processing modules with varying computational demands.

Marc Tchiboukdjian, system architect at CGG, explains: "Geovation is central to our service to upstream oil and gas businesses. As our geologists and geophysicists develop more sophisticated techniques for gathering data, our team of software developers continues to enhance Geovation's capabilities so that it can handle massive high-density datasets and run the latest computationally-intensive imaging algorithms."

Powering advanced algorithms

HPC is strategically important for CGG and is key to the continuing performance of the more computationally intensive

modules within Geovation. To ensure Geovation continues to meet the rapidly growing demands of seismic processing, CGG needed to expand its HPC capabilities.

As Tchiboukdjian explains, "Our scientists had developed the techniques to produce greater volumes of data at greater frequency. We needed more computationally intensive algorithms that could carry out seismic processing and produce high-resolution imaging in a suitably short timeframe. We wanted to optimize our application and reduce operational costs to keep our business competitive."

CGG opted to work with 2CRSi, a Strasbourg-based company that specializes in the design and manufacture of computer servers and industrial systems. 2CSRi developed custom-built 2U* servers for CGG, powered by the Intel® Xeon® processor E5-2620 v2 product family, which provide 12 cores in total, plus six Intel® Xeon Phi™ 5120D coprocessors (dense form factor), which provide an additional 360 cores.

Parallel processing

The new servers are installed at CGG's site in Massy, France, alongside CGG's existing compute nodes, which are powered by the Intel Xeon processor E3 v3 family. This cluster is dedicated to the work of CGG's R&D department, which focuses on recompiling and optimizing the code of its most compute-intensive modules on the Intel Xeon Phi coprocessors. CGG will then port the code onto a future cluster powered by 2nd generation Intel Xeon Phi product family, which is designed to provide improved single-thread performance as well as binary compatibility with the Intel Xeon processor in a standard CPU form factor. CGG will be able to scale from a few cores to many cores using consistent models, languages, tools, and techniques.

Tchiboukdjian explains: "We can take code optimized for our existing Intel Xeon processors and execute it in an HPC cluster without rearchitecting. It helps keep our development costs low and significantly reduces the risks associated with porting our complex and business-critical code to a new high-performance computing cluster."

CGG also deployed the Intel SSD DC S3500 series, which offers fast, consistent read performance with strong data protection and low active power levels. Tchiboukdjian says: "The Intel SSDs are an integral part of the solution. They help balance greatly expanded processing power by supporting high levels of throughput. We couldn't have one without the other."

Lessons Learned

The Intel® Xeon Phi™ coprocessor is accompanied by a set of programming aids like compilers, libraries and tools which help task and data parallelization. By using these tools, which include support for vectorization among others, and by working in close collaboration with Intel's own teams, CGG was able to optimize its code for the new cluster more easily and secure improved performance from its HPC cluster.

Improved performance, better science

Internal assessments at CGG have shown improvements in computational performance per node in the new HPC cluster. Each Intel Xeon Phi coprocessor in the cluster is approximately four times faster than a node in CGG's existing cluster based on the Intel Xeon processor E3 v3 family, and just as fast as a dual-socket Intel Xeon processor E5 v2 family node.

The company's scientists will be able to produce more accurate seismic models, with higher resolution and within a commercially acceptable timeframe from their existing algorithms. They will also be able to develop new applications within Geovation for even greater commercial appeal.

Tchiboukdjian concludes: "We can run our most computationally intensive algorithms on the Intel Xeon Phi coprocessors, while running less demanding sequences on the Intel Xeon processor family, for the most efficient use of our IT estate. We can transition modules to our HPC cluster with minimal risk as it becomes appropriate. In a field as competitive as ours, that's an important advantage."

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[1] Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.

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