Repsol shows the future of offshore exploration with more powerful and detailed seismic imaging

Overview

- ***Business Challenge***
  For its oil exploration activities in the deep waters of the Gulf of Mexico—a region known for complex geological conditions that make finding oil and gas hard—Repsol needed to augment its seismic imaging capabilities to reduce the risk of drilling "dry holes" and shorten the time to "first oil."
- ***Solution***
  Repsol worked with IBM to build a powerful new system capable of running the next generation of more accurate seismic algorithms—and do so faster than the rest of the industry. Leveraging advanced multi-core technology, and optimizing algorithm code for maximum performance—Repsol can spot likely opportunities for oil and gas discovery more accurately and bring it to market faster.
- ***Key Benefits***
  - *85 percent reduction in time required to run next generation seismic algorithms*
  - *Substantially lower power and cooling costs*
  - *Fewer dry holes and wasted resources*

Repsol is an international integrated oil and gas company, operating in over 30 countries. It is the leader in Spain and Argentina, one of the ten largest private oil companies in the world and the largest private energy company in Latin America in terms of assets.

The world's petroleum producers recognize that when it comes to finding and exploiting new sources, the days of "easy oil"—that which is found in large reservoirs either on shore or in shallow coastal waters—are largely over. The new frontier for exploration, and the biggest hope for future large discoveries, lies farther offshore, in reservoirs miles beneath the seafloor in waters that can be miles deep. These extreme conditions make deep-water oil exploration and production an expensive proposition. In the Gulf of Mexico, for example, the total cost of developing a deep-water field is often measured in

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>
> – *Francisco Ortigosa, Director of Geophysics, Repsol YPF*

Business Benefits

- 85 percent reduction in time required to run the next generation of highly accurate—and compute-intensive—seismic algorithms
- More detailed rendering of complex subsurface structures such as salt domes, resulting in fewer dry holes and wasted resources
- Faster time to market for new oil and gas properties by shortening the seismic data analysis phase
- Reduced risk in bidding for offshore oil and gas leases
- Substantially lower power and cooling costs resulting from the increase in computing efficiency enabled by the multicore optimization of Repsol's seismic algorithms

"Our ability to leverage advanced seismic algorithms fundamentally changes the way we manage the risks and seize the opportunities of deep-sea oil exploration."

– *Francisco Ortigosa*

the billions of dollars, while the cost of operating just a single offshore platform exceeds half a million dollars per day. That's not to mention the perennial threat of hurricanes damaging infrastructure and disrupting exploration and production efforts. What draws many of the world's largest oil exploration and production companies to the Gulf of Mexico despite these costs and challenges are the region's enormous reserves of recoverable oil, a figure the U.S. Department of the Interior's Minerals Management Service puts at 56 billion barrels.

Getting a better picture

While pinpointing the exact location of oil and gas reservoirs is always a challenge, the geological complexities of the Gulf of Mexico accentuate the challenge considerably. More than 100 million years ago, evaporating seas left a thick, extremely dense layer of salt, which was then gradually covered by the newer sediments that make up today's seafloor. Over time, intense pressure caused the salt to well up at various points and form "salt domes," mushroom shaped structures that proved ideal for trapping oil deposits but are notoriously difficult to see beneath. To find oil deposits, exploration companies use advanced seismic imaging technologies to get as detailed a picture as possible of the subsurface landscape, much like magnetic resonance imaging is used to scan the inside of a human body. The level of detail ultimately achieved is a function of complex algorithms, which translate huge amounts of seismic data into 3-D maps that are then visually interpreted by teams of experts. Like any business decision, their judgment—as to the presence of possible hydrocarbon-bearing structures—is only as accurate as the data it's based on.

Therein lies the unique challenge of salt domes. Because of crystalline structure (which creates "noise" in the seismic data), it takes far more complex algorithms to achieve the accuracy oil companies need to drill precisely in the right location and thus avoid "dry holes," whose costs can exceed $125 million. As an oil and gas company with a big stake in the Gulf of Mexico, Madrid-based Repsol (www.repsol.com) was determined to maximize the effectiveness of its exploration efforts—which meant adapting its methods to meet the challenges posed by salt domes. Its intent was to better delineate geological structures deep below the surface by applying a far more powerful algorithmic approach known as reverse time migration, whose extreme computational intensity had until then prevented oil companies from employing it. Repsol turned to IBM to help make this significant breakthrough in applied seismic techniques.

Companies involved in oil exploration need to make practical decisions. They need to know when and how much to bid on offshore drilling leases. And perhaps most importantly, with oil more likely to be found in smaller, localized pockets, they need to know where to drill. Given the huge financial stakes and the limited duration of

drilling leases, time is the enemy. A dry hole exacts not only explicit drilling costs, but also the cost of missed opportunities and delayed cash flow, both of which destroy value. The same logic holds true for pre-drilling analysis. Despite its importance, oil companies simply can't afford to delay their exploration programs by running seismic algorithms that can take as much as four months to run. That's why—when faced with the trade-off between imaging precision and computational time—oil companies largely choose the latter out of necessity.

Making the jump to more accuracy

Repsol, however, believed that the unique challenges of deep-sea drilling in the Gulf called for a rethinking of this paradigm, and that the key to enabling this change was a quantum jump in computational capabilities that would make reverse time migration practical. Like its peers, Repsol has long relied on supercomputing clusters to run its seismic algorithms. In mapping out its next strategy, the company saw the use of higher performance multicore processors as integral to its plans. What became increasingly clear over time, however, was just how important—and challenging—it was to optimize seismic algorithms to fully leverage multicore technology. After evaluating servers based on quad core technology, Repsol saw that processor scalability limitations would necessitate a much larger infrastructure to handle its massive computing requirements, which would produce unacceptably high power and cooling costs. That's when it took a closer look at the IBM PowerXCell™ 8i processor.

In the PowerXCell 8i, Repsol saw not only the power of its heterogeneous, nine-core processing architecture—which is well-suited to the specialized processing demands of reverse time migration—but also the opportunity to fully exploit it by capitalizing on the unmatched expertise of IBM Research in optimizing algorithms to run on multicore systems. What's more, Repsol saw the PowerXCell's 16-x advantage in computing power per watt as a way around the power and heat dissipation issues that would threaten the viability—both economic and technical—of a less efficient architecture. Repsol ultimately chose the PowerXCell 8i, running on a series of IBM BladeCenter® QS22 blade servers as the foundation of an initiative now known as Project Kaleidoscope.

Deployed by IBM located in Houston, Texas, the Project Kaleidoscope infrastructure is comprised of 288 IBM BladeCenter QS22 blade servers supported by a large network of IBM TotalStorage® storage hardware. In parallel with this deployment, staff from IBM STG Cell Ecosystem & Solutions Enablement Group and the IBM T.J. Watson Research Center's Multicore Computing Group worked closely with parallelization experts from the Barcelona Supercomputing Center (BSC) to optimize the reverse time migration algorithms for peak processing on the

Solution Components

Processor

- IBM PowerXCell 8i

Hardware

- IBM BladeCenter QS22
- IBM System Storage™
- IBM TotalStorage

Services

- IBM T.J. Watson Research Center – Multicore Computing Group
- IBM STG Cell Ecosystem & Solutions Enablement Group

Smarter Petroleum Exploration

Repsol is breaking new ground in improving the accuracy of deep-sea oil exploration by harnessing the most powerful and efficient multicore processing technology on the planet. By building a new seismic computing infrastructure—and optimizing its seismic algorithms to fully leverage its advanced multicore properties—Repsol can now run the most comprehensive algorithms, which have until now been out of reach of oil and gas companies due to their extreme computational intensity.

PowerXCell. Testing of the system on BCS's MareNostrum supercomputer—built by IBM and the most powerful in Europe—showed that IBM PowerXCell 8i processor ran these algorithms as much as six times faster than existing seismic analysis platforms.

Changing the game

In the larger scheme, Repsol's embrace of a new approach to processing seismic data puts the company in a stronger competitive position because it has gained the ability to look deeper into seismic data—without having to compromise the timing and quality of its decisions. In this sense, Repsol has broken through the accuracy-versus-speed trade-offs that have defined seismic exploration until today. It has done so by reducing the time required to run complex imaging algorithms like reverse time migration from four months to two weeks. Access to more detailed and fine-grained seismic images enables Repsol to make more accurate and data-driven drilling decisions, substantially mitigating the risk of dry holes associated with the Gulf of Mexico's salt domes. Elsewhere, this richer view of potential petroleum deposits provides Repsol with an advantage in bidding for offshore properties, both by lessening the likelihood of paying too much and helping Repsol spot undervalued properties.

Francisco Ortigosa, Director of Geophysics, sees Repsol's leadership in the area of advanced seismic algorithms as greatly enhancing the company's ability to find and capitalize on the Gulf of Mexico's rich deep sea exploration and production opportunities. "Our ability to leverage advanced seismic algorithms fundamentally changes the way we manage the risks and seize the opportunities of deep-sea oil exploration," says Ortigosa. "In the same way, we see IBM's technology and expertise as game changing in the area of oil exploration because they enable a new level of analytical insight that fits with our need for cost effectiveness, sustainability and fast time-to-market."

For more information

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