Using video-game technology to find oil, gas

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Arthur B. Weglein, director of the Mission-Oriented Seismic Research Program at the University of Houston, is pictured with IBM's Cell Broadband Engine (Cell/B.E.) system. The Cell/B.E. employs computer technology originally co-designed by IBM for video-game consoles, and UH seismic researchers are employing this extremely fast technology to more effectively target oil reserves. UH's M-OSRP has the Cell/B.E. as part of a very exclusive 'Loaner Program' from IBM. Credit: Thomas Shea

What do video games and seismic explorations have in common? Both require very demanding computer applications that call for the ability to process massive quantities of data rapidly. Using computer technology originally co-designed by IBM for video-game consoles, University of Houston seismic researchers are employing this extremely fast technology to more effectively target oil reserves.

IBM is supporting the UH Mission-Oriented Seismic Research Program (M-OSRP) and its petroleum industry sponsors with a Cell Broadband

Engine™ (Cell/B.E.) system that represents a new generation of powerful supercomputers with substantial parallelism built in at the core level. Such highly parallel computing technology is characterized by multiple processors executing and analyzing different types of data at once.

Originally designed for use in consumer-based computer entertainment products such as the Sony PlayStation3, the Cell/B.E. processor is not limited to game systems and delivers supercomputing performance on a single chip through the architecture of the Cell Synergistic Processor Unit (SPU) for data-intensive processing like that found in cryptography, media, matrix operations and certain scientific applications. Current Cell/B.E. processors have up to nine individual core units per chip and future plans envisage having 34 core units. This design has a great advantage in running programs that require the same algorithm – a repetitive, problem-solving computational procedure – to be run independently on a common data set.

In seismic exploration, algorithms are used to process seismic data to remove coherent noise and to locate and produce hydrocarbons. Seismic methods are successful when the assumptions behind processing algorithms are satisfied, and they fail when those assumptions are violated. The latter breakdown of seismic efficacy is the source of challenges faced by seismic exploration and production.

There are several types or categories of assumptions made by seismic algorithms, such as collecting enough surface data to make reliable subsurface inferences and having computers with adequate speed and memory to allow realistic turnaround time. Additionally, there are innate algorithmic assumptions or limitations whose violation cannot be addressed by collecting more data or inventing and purchasing faster computers. There are many cases when collecting more complete data and having faster computers with greater memory will match the

challenge, but there are other cases when the issue is innate algorithmic failure and a different response is required.

Many significant and challenging exploration targets, such as sub-salt and sub-basalt exploration and production, represent intrinsic algorithmic breakdown and failure. A fundamental new seismic concept and capability is required to address such an innate algorithmic failure, and that new algorithm often has a concomitant requirement for increased computing power. An effective and comprehensive response needs to begin by first recognizing and then responding to each of these different types of challenges. IBM's Cell/B.E. processor has the potential to significantly contribute to several different aspects and initiatives within that campaign.

One of the algorithms developed within M-OSRP to suppress a form of coherent noise called internal multiples places a high bar on seismic data collection and a very high bar on computing speed and memory. To allow the petroleum industry to use this very effective methodology for 3-D data will require a new computing vision and capability.

IBM researchers working in cooperation with M-OSRP have recoded this M-OSRP algorithm for the Cell/B.E. processor at UH and are running comparisons with industry-standard computer architectures and other novel architectures including Cell/B.E. The IBM research team is managed and directed by Tom McClure, leader of IBM's Worldwide Petroleum Industry and Deep Computing Visualization Team; Michael Perrone, IBM Master Inventor and manager of the Cell/B.E. Applications Group; and Earl Dodd, Deep Computing strategist. On the UH side, Cullen Distinguished Professor of Physics Arthur Weglein is the director of M-OSRP.

IBM and M-OSRP have a special relationship involving cooperative, collaborative and sponsor support, and while IBM sells this machine, it

does not lease it. The Cell/B.E. is on loan to UH's M-OSRP as part of a very exclusive program with academic and research institutions.

"The IBM team's astute technical vision, impressive capability and business acumen not only recognize the breadth and depth of the E&P challenge, but also that partnering and collaborating with M-OSRP and its petroleum industry sponsors provides a reasonable chance of contributing toward an effective and comprehensive response," Weglein said. "The key responsibility of our group is to educate and mentor graduate students to become the next generation of scientific research leaders while addressing innate seismic algorithmic assumption violation and failure. Our research purpose is to provide new, high-impact seismic capability, methods and algorithms – the 'what to compute.' However, many of our algorithms are extremely computer intensive and their new level of effectiveness requires a matching new computing vision and capability."

The two issues of "what to compute" and "how to compute" must be simultaneously progressed for M-OSRP's new seismic concepts and capabilities to be relevant. That fact, Weglein said, is behind the collaboration and cooperation between IBM and M-OSRP and its petroleum-industry sponsors.

A broader and central objective in making this IBM technology available to M-OSRP is to see how the Cell/B.E. supercomputer functions in a real-time atmosphere and how to design the optimal machine for seismic activities. The M-OSRP sponsors have a High-Performance Computing Committee that manages and guides that activity in cooperation with IBM and M-OSRP.

"We are very fortunate to have the trust and confidence of our industry sponsors to pursue high-impact, fundamental, game-changing research designed to make the currently inaccessible target accessible and the

accessible better defined," Weglein said. "Our partnership with IBM contributes to an effective and comprehensive response to the pressing challenges faced by the petroleum industry in locating and producing hydrocarbons. Located in Houston, the center of the petroleum universe, UH is the ideal place for this partnership to flourish. The success of this initiative has important implications for both our nation's and the world's energy and security interests."

Source: University of Houston