NICKLE'S
New Technology magazine
April 2008

# Upside To Downsizing

ACCELEWARE'S GRAPHIC PROCESSOR TECHNOLOGY
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## OILPATCH SOFTWARE

ACCELEWARE'S GRAPHIC PROCESSOR TECHNOLOGY PROPELS SEISMIC DATA PROCESSING REVOLUTION BY MAURICE SMITH

# Upside To Downsizing

**HAD RICK STEELE, PRESIDENT OF** junior seismic processing company P-Wave Imaging Ltd., known a new, smaller and faster processing technology was on the way to market, it's unlikely he would have chosen the cumbersome cluster computing technology he so heavily invested in.

Since trying the latest generation, graphics processing unit (GPU) accelerator technology, Steele has been won over by its small footprint, low wattage, high-speed advantages.

"Had they been around when I first got into this and was buying new equipment, I might have considered just plugging a couple of these [GPUs] in the back of each of my desktops," he says. "Instead of bulking up too much on CPUs [computer processing units], you could just have these GPUs that are there when you need them and can really boost your power."

Steele was among the first to pilot Acceleware Corp.'s new GPU accelerator technology, which the company says brings supercomputing speed to the desktop by leveraging the massive parallel processing capacity of the very latest in GPU technology — a technology originally developed largely for the exploding computer gaming market.

As with gaming, speed is the name of the game in seismic processing. Among the most computationally intensive of industries, seismic processing seems a natural for a technology that can boost performance by as much as a factor of 35 times, reducing month-long computational tasks to days or hours.

"In order to turn around the data, you have to have a lot of CPUs available. If you are dealing with a fairly large project and you don't have the CPU power, you could be waiting for a month or two for your job to finish," Steele says. "And to buy the CPU power you have to start generating your own cluster and maintaining all these different units — you have got to provide electricity and air cooling for them et cetera. Acceleware can reduce the amount of hardware you need — one of their GPU solutions is equivalent to five to 10 CPU cores.

"The other thing is that, with GPUs, they are expected to dou-

ble in speed over the next year, so then you would expect to get 10 times [the performance] on land seismic and 20 times on marine, whereas the CPUs seem to have plateaued — I think they have reached a point where squeezing that next level out of them is getting harder and harder."

### GPU ascendancy

Originally dedicated to computer graphics, GPUs, which can be a stand-alone component as a desktop solution or be integrated into the mother board, took much of the load off CPUs to greatly speed up processing. Their highly parallel structure — they can simultaneously perform 128 or more tasks in parallel compared to the typical two or four tasks in parallel performed by multicore CPUs — and enormous floating-point computational power makes them ideal to take on complex data processing and data-intensive simulations. Additionally, as mass-produced products, graphics cards are cost-effective compared to special-purpose computing alternatives.

In recent years, GPUs have emerged as general-purpose processors, providing as much as several orders of magnitude greater performance than conventional CPUs in the performance of certain tasks. They are proving to be a boon in fields where intensive computer modelling is required, such as seismic data processing, financial modelling, biomedical imaging and electromagnetic simulation.

Founded in 2004, Calgary-based Acceleware was among the first to recognize the potential for GPUs to surpass the performance of CPUs in data-intensive tasks. The company has already leveraged the technology to gain a foothold in the electromagnetic modelling industry — primarily involving telecommunications and electronic design automation (EDA) industries — gaining such prominent customers as Boeing, Research In Motion Limited, Sony Ericsson and Mitsubishi.

"We have a track record of establishing a really strong presence in an industry before deciding to take on another industry," says Steve Joachims, Acceleware's vice-president of business development, a 25-year veteran of the high performance computing and petroleum industries who was brought in last September to help the company break into the seismic industry. "We are unique in that we are really the first company that has been built on the premise of being an end user software developer that builds the expertise to be able to deploy and support major applications on the graphics processor."

Following field trials with several seismic companies in 2007, Acceleware officially launched its seismic product offering in Calgary in January. It also branched into a third area, the medical imagery and security sectors, with image reconstruction technology, in March.

"In the seismic industry, we see compute-intensive simulation and models that cause most computers to just keel over — it can take days or weeks sometimes to run these complex simulations on a computer or even a cluster of computers," says Joachims. "Acceleware develops the algorithms on the graphics processor with the goal of achieving an order-of-magnitude speedup — we have been able to speed up some simulations by as much as 35 times."

Graphics cards are key to enhancing computational speed. "You can plug a high-performance graphics card into a computer system and use that as the turbocharger for the engine the computer is already providing you. We enhance existing software or develop our own software that will run on that graphics processor, to be able to kick in the turbocharger, if you will."

### Kirchhoff entry

Acceleware choose the Kirchhoff pre-stack time migration processing method as its launching pad into the seismic industry because it is the most common migration solution in use globally, says Joachims. Such processing methods allow the echoes recorded by seismic surveys to "migrate" to their true subsurface position, a process required to accurately image subsurface geology in complex areas.

"No matter what collection of migration techniques a processing centre uses, at the end of the day over half of their computer resources are dedicated to Kirchhoff pre-stack migration, so we have gone after the industry workhorse first."

Acceleware ran a comparison of various processor configurations when benchmarking its accelerated version of Techco Geophysical Services Ltd.'s SUMMIG Kirchhoff time migration seismic processing software. Compared to a single core CPU, it found a performance factor increase of 23 times for its deskside dual-GPU DS30 accelerator package, and a performance lift of 45 times with its rack mounted quad-GPU QS30.

"When a simulation is going to take a week to run, and that's pretty common for medium-sized simulation seismic data processing, running it in less than a day changes a lot of dynamics. The geophysicist who is using this computer simulation will joke sometimes that if they can run something in less than a day they can remember what questions they were asking of the simulation when they ran it. After a week, they are looking for the sticky notes to remember what it was they were trying to accomplish."

While Kirchhoff was the starting point, Acceleware is moving quickly to address other processing methods — some of which, like reverse time migration, are caught in a performance bottleneck right now due to computational limitations — and it also plans to add reservoir simulation to its repertoire soon. "We are firmly committed to this market and we are growing rapidly by bringing in experienced industry professionals and other capable intellectual capital that allows us to effectively deliver solutions to this marketplace," Joachims says.

### Powerful partner

Acceleware chose Santa Clara, California-based Nvidia, a leader in programmable graphics processor technology, as a partner for its hardware technology because "they were just leagues ahead of everybody else," Joachims says. "And it wasn't long after we made that strategic decision that Nvidia chose to make an investment [of $3 million] in Acceleware. I believe they see software developers like Acceleware as being one of the most critical components that they need to be successful with their hardware — they are critical to our success and companies like ours are critical to their success."

Nvidia's industry standard GPU technology is a high volume, broadly supported product that has hundreds of millions of dollars of investment going into it every year, keeping it at the leading-edge of high-performance hardware development, Joachims notes. Nvidia's main GPU competitor, Markham, Ontario-headquartered ATI Technologies U.L.C., was purchased by microprocessor maker AMD in 2006. AMD's main competitor, Intel, meanwhile, plans to enter the GPU market in a big way later this year.

"[Graphics cards] were designed initially for the purposes of doing 3D rendering and graphics processing at just terrific performance levels and for years the folks in the gaming industry and people who were familiar with the technology kept pounding on Nvidia and ATI to release their graphics processors for other purposes because they were so far ahead of what Intel and AMD were providing for computing. So, Nvidia did, and right behind that ATI did, so there is a lot of

competition and a lot of investment that is going into GPUs."

### Software friendly

One of the advantages with Nvidia, Joachims says, is its creation of a software development environment that is very programming-friendly. "Nvidia is well ahead of the game in terms of providing a familiar software development environment that we and others can use to be able to get performance and acceleration development applications on the system."

That, combined with Acceleware's dozens of experts with extensive experience in developing applications on graphics processors, allows the company to "squeeze every ounce of performance out of an application.... We are able to structure codes to fit well on one or more graphics processors and we can get order-of-magnitude performance speedups when somebody lacking GPU programming might get two- or three-times maximum [performance]."

Acceleware's bundled solutions integrate seamlessly with its partners' proprietary software applications, ensuring that acceleration is optimized based on the requirements particular to that industry, the company says. And setup is quick, says Joachims, pointing to a recent Calgary installation. "We had it on their corporate network running production code in less than 45 minutes from the time we showed up with the hardware at their front door. They are running the same application they ran before, we just accelerated it."

Integration of Acceleware's core technology with third-party applications is not a problem, he says, with customers deciding how much integration they want. In most cases, clients prefer the hardware and software packaged together as "an appliance," he adds. "It's almost like buying a toaster that you just plug in, turn on and use. We can deliver just the software we've developed, or a complete appliance, but in 90-plus per cent of the cases in our business, customers really have a strong preference for the appliance."

### Smaller footprint

Acceleware's compact hardware has another advantage immediately apparent to firms confined in small offices in high-rent downtown skyscrapers — it both takes up a fraction of the space and uses up to 70% less power. "Many companies, particularly in downtown Calgary, have a limit on how much processing they can do. In some cases the power cables that come into the computer facility dictate how much compute power they have and therefore how many computer systems they can run in a cluster. We are able to increase that ceiling for them substantially. And of course their revenues are tied directly to their processing capacity."

In a comparison of traditional CPU servers (a 160 CPU-only server cluster using four cores per server) against an equivalent setup using Acceleware's acceleration technology, the company calculated the annual power consumption and cooling costs would be $51,653 versus $15,228. The company estimates savings of more than $3,500 annually per accelerated server, or up to tens of thousands per year for large installations.

While Acceleware will be targeting a worldwide market, it chose Calgary to enter into the seismic industry. "That's a natural market for us to focus on because there are so many seismic processing companies in Calgary and it's just around the corner [from head office]. We wanted to demonstrate that the technology is rock solid, and just the fact that we are right down the road from them gives everyone a comfort level that supportability is a certainty," says Joachims, who has recently begun courting companies in Houston as well. "We certainly want to grow our business in North America as a first step and expand quickly into the global market."

As well, many of the company's executives have connections to the city. Company co-founders Sean Krakiwsky, president, and Ryan Schneider, CTO, hold University of Calgary master's degrees in electrical engineering, while chief scientist Michal Okoniewski, an expert in applied computational electrodynamics and micro-machined devices, is on sabbatical from the U of C, where he holds a faculty position in the Electrical and Computer Engineering Department and is Canada Research Chair in Applied Electromagnetics.

P-Wave Imaging's Steele says that while he is impressed with Acceleware's processing speed, the range of uses for the high-octane solution remains somewhat limited today. "The only thing we can run today is the migration, so we still need CPUs for other tasks. So it's one of those things where you have to decide whether you want to buy more CPUs so you can run just about anything on there, or do you want to buy these GPUs and accelerate the time migration. As you look toward what to buy next — extra CPU or GPU — it's going to depend on what you need the power for, whether it's for the migration or it's for another step in the process.

"Now as time goes on, they will probably address more algorithms because they are just getting into seismic processing," adds Steele, an industry veteran who launched his own company two years ago. "I don't know how it's going to shake out in the long run, but it definitely looks like an alternative." ntm


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