



## SUN GRID SYSTEM UNIVERSITY OF QUEENSLAND

### Key Challenges

- Increase computational power
- Analyze substantial scientific data
- Accelerate compute and compilation time
- Increase throughput
- Achieve optimal price/performance and manageability

### Solution

- 66-node Sun Grid System
- Sun N1™ Grid Engine
- Sun Fire™ V20z servers
- Sun Customer Ready Systems Programs

### Results

- Reduction in compute time from three years to two weeks
- 20 percent increase in throughput in half the physical space
- Remote management capability
- Increase in complexity and number of calculations
- Increased support for multiple users

Two research units at the University of Queensland (UQ) needed to augment their 128-node grid system. A new, 66-node Sun Grid System increased throughput by 20 percent, while taking up about half the physical space.

The University of Queensland, Australia, hosts two strategic scientific hubs: The Centre for Computational Molecular Science (CCMS) and the Centre for Hypersonics. Driving research at both facilities is a two-rack, 66-node Sun Grid System using Sun Fire™ V20z servers powered by the AMD Opteron™ processor Model 250. Sean Smith, Professor and Director of the Centre for Computational Molecular Science, had such positive experiences with Sun systems that he piqued the interest of Richard Morgan, Professor and Director of the Centre for Hypersonics. Now, not only do both research centers rely on the current Sun Grid System, but also look forward to using the new 90-node Sun system that has just been ordered.

The Centre for Hypersonics specializes in aerodynamics, studying air flow at velocities of at least five times the speed of sound. The Centre is primarily an experimental facility and has devised what are, in essence, high-speed wind tunnels to duplicate the speeds needed for space flight. Through these “shock tunnels,” scientists produce and analyze experimental data that’s very difficult to get any other way than flying into space. Travel at that speed creates a number of variables to be considered. High speeds create enough heat, for example, to cause gases to react with one another. The Centre is also developing a propulsion system, which involves analyzing enormous amounts of data. The Centre’s research requires a tremendous amount of dedicated computational power, and that’s what Sun Grid System delivers.



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**Dr. Peter Jacobs**

Senior Lecturer in Engineering

CCMS works to develop critical capacity in molecular scale computations in interdisciplinary contexts, linking research in chemistry, biology, and engineering. Its work overlaps with that of the Centre for Hypersonics in the area of chemical reactions that occur during travel at hypersonic speed. While the Centre for Hypersonics concentrates on fluid dynamics, CCMS focuses on computational chemistry.

“When we’re doing experiments,” says Morgan, “we’re always delving into new areas of flight, where we don’t know what the result will be. We get the data and then computers are required to analyze that data and compare it with existing theories and new theories. Without that analysis, the experiments we do are pretty well meaningless. So the computers are the fundamental support for what we do.”

**Sun Grid System advances hypersonic research**

After only a few months of operations on the Sun Grid System, Morgan notices a distinct difference in performance. “It’s much more supportive of multiple users. We’ve been able to get a lot more graduate students involved in our research,” says Morgan, who finds that the new system is not only easier to access, but also delivers more continuous operations. Morgan particularly notices improvements in experiments on the Centre’s project known as the Expansion Tube, which is essentially a high-speed wind tunnel for testing space flight including, for example, the aerodynamics of the capsule recently sent to Saturn’s moon, Titan.

Each Sun Fire V20z is equipped with four gigabytes of memory and two AMD Opteron processors Model 250. The high performance and processing speed of the servers has made a concrete difference in the quality of research aerodynamics. “Previously,

we could only run a very few sample test conditions because it just took so long to run the computer. With this powerful Sun facility, now each time we look at a new condition, it’s not really a problem. We can now run a computer simulation in tandem with the experiment. Before, we’d have to do limited simulations in restricted areas of research. Now there’s no limit to what we can do; we’ve greatly expanded the regions of the flow that we can properly analyze and this has added real value to our experiments.”

Both Centres take advantage of the Sun Fire V20z’s ability to run a variety of operating systems. The 66-node Sun Grid System runs both Red Hat Linux 9 and Fedora Core 2 and Fedora Core 3 with Sun N1 Grid Engine driving the system. Populated with 66 Sun Fire V20z dual-processor servers, the system is generally accessed by 30 to 40 users at any given time.

Dr. Peter Jacobs is a Senior Lecturer in Engineering who works at the Centre for Hypersonics, but also interacts with researchers in computational chemistry. He was involved with CCMS before the current Sun Grid System was installed, and saw Sun’s presence at the facility come in stages.

Initially, CCMS purchased a Sun machine to run a 256-node Xeon-based system. Jacobs first got familiar with the cluster when Director Sean Smith was looking for partners to share the system, and, “Hypersonics pitched in as one of the research groups around that had an interest in lots of compute power. We were a small player at that point,” says Jacobs. “Some months later, an opportunity came up with the Queensland state government to sponsor research infrastructure in the state. As part of a bigger exercise, Sean and Richard put in a request for computational support to expand the cluster capability at CCMS, and Hypersonics

along with it. That was combined with corporate sponsorship from Sun.”

Sean Smith adds that the proposal for the grid was “...about 20 percent of a larger successful bid for a grant for a testing facility based on Hypersonics.”

That original Xeon-based cluster is being phased out, but is still running with the newer Sun Grid System based on the AMD Opteron processor Model 250 running next door. Sun N1 Grid Engine runs the cluster of Sun Fire V20z servers, as well as the Xeon cluster of 128 V60x machines, each with two 2.8 GHz CPUs.

### **Speed, power, and price/performance**

Jacobs says installing the Sun Grid System was meant to ensure plenty of compute power. “The University as a whole has run a supercomputing facility. But there are a lot of research groups on campus now, and it was just not enough. Sun Grid System gives you more compute nodes for less money than other machines. Sun delivers more mega floating-point operations per second (MFOPS), per dollar. We had run smaller clusters of competitors’ machines over the years. They didn’t run nearly as fast as the Sun machines. For the ones we’re running in Hypersonics, we got much faster performance on the Sun systems, and they were a lot cheaper.”

According to Jacobs, the installation process was simple. “We just had them deliver the machines, plugged them in, and got them going. The only limitations on implementation had to do with the physical surroundings: Making sure we had a room that could deal with the heat from the machines—each rack uses about 10 kilowatts, so you have to make sure you have a decent air conditioning system.” According to Dr. Jacobs, the Sun Grid System has made dra-

matic improvements in research at the Centre for Hypersonics. Like many other scientific endeavors, the Centre’s research hinges on both the complexity of the calculations and the number of times they can be repeated. The Sun solution has been instrumental in maximizing results on both fronts. “More users are using larger codes now, so they’re doing more ambitious compilations related to the Expansion Tubes,” says Jacobs. “People using the system for design work have access to a hundred times more compute power than they had previously. The same is true for computational chemistry. There were experiments we wouldn’t previously attempt because processing the data would take up to three years of compute time. Now we can conduct those experiments with perhaps two weeks of compute time.”

The speed of the AMD Opteron processor Model 250 in the Sun Fire V20z server is critical to the success of the experiments in the Centre for Hypersonics. But even at CCMS, where memory is more critical, the architecture of the Sun Grid System has proved to be an improvement over the earlier, Xeon-based system.

### **Greater throughput and competitive pricing**

With its memory capacity up to 16 gigabytes, the Sun Fire V20z has changed the standard for high-performance computing. CCMS Director Sean Smith says, “Essentially, the improvement in our research all hinges on throughput. When we assessed our needs in this area, we decided that the large-scale, shared-memory architectures were not really what we needed. The power of 64-bit processors has developed to the stage that on one Sun dual-processor node you have enough memory and disk space—and a fast enough processor—to handle about 90 percent of our calculations. There is some small fraction for which we do need

large shared-memory systems, but there’s no question that most of our calculations are of the magnitude that will run through quite nicely on one of these nodes. We need to be able to run lots and lots of these calculations, and that’s why we decided to go with the cluster format with the Sun Fire V20z.” The old system was based on 32-bit Xeon processors and could not match the speed of the Sun Fire V20z powered by the 64-bit AMD Opteron processor Model 250 nor could it handle the throughput. The benefits of the new system are two-fold. First, the system takes up about half the physical space of the old system, a fact that Smith appreciates at an institution where space is at a premium. Second, the throughput has increased by 20 percent.

“We also found,” says Smith, “that a lot of things relating to compilation and installation of packages and also parts of the Linux kernel for the operating system seem to work better on the new Sun Grid System. Just the fact that the engineering and the architecture of these systems are more mature means that the system runs more smoothly than it did with the old grid.”

In addition, the architecture has helped CCMS gain the ability to monitor the system remotely. “To be able to monitor what the running temperature is, for example, seems to be better with the new Sun Grid System than with the old grid.”

In evaluating the Sun offering against the competition, Smith says, “We pretty much knew what you could get out there for a particular outlay. Sun was extremely competitive in that regard. Additionally, we had good experiences with Sun, and had appreciated developing a professional relationship with Sun. Sun has nominated our Centre at UQ as a Sun Center of Excellence, which

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**Sean Smith**

Professor and Director, CCMS

is something they use to profile this kind of science being done on their hardware, but it also does provide a framework in which we can develop a working relationship with Sun, and that’s been a useful adjunct.”

Smith says that the Centre was so pleased with the architecture that they just purchased an additional 90-node system from Sun. Looking to the future, Smith points to the joint proposal made by Sun’s Asian Pacific Technology Centre in Singapore and CCMS to the Australian funding body for improvements in the middleware and file system that connect to the grid. “Any downtime we experience has nothing to do with the grid itself, which runs beautifully, but rather is often related to the middleware or network file system, which is hooking the grid up to the front-end machine.” Smith recognizes that part of the solution to this problem may well be the installation of Solaris™ 10 OS, with its sophisticated file system and ability to run Linux® applications. Whatever the ultimate solution, the Sun/UQ partnership will continue to build on the dramatic advances it has made in its research community.

**Learn More**

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