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Success Story

# University of Warwick

# Scaling research with SGI® servers and storage

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*– Rudolf Roemer, Physicist and Associate Director, Centre for Scientific Computing*

In the next decade, ever-shrinking microprocessors will bump into the quantum limit imposed by the laws of physics. At that point, processors simply won't be able to get any smaller, at least not without suffering too great a trade-off in performance. This can be worrisome to technology product providers who bank on their products growing not just smaller but increasingly more powerful.

At the University of Warwick in the heart of England, researchers are toiling to solve the equations for disordered quantum systems. It sounds esoteric, but research like this may provide the key to designing new generations of miniature processors and other devices powered by nanotechnology.

"We can use these studies to better understand transport processes that are relevant to future computing applications or for generating nanotechnology," says Rudolf Roemer, Physicist and Associate Director at the university's Centre for Scientific Computing (CSC), a research centre specializing in centralized high-performance computing (HPC) resource that services 35 of Warwick's mostly graduate academic research groups.

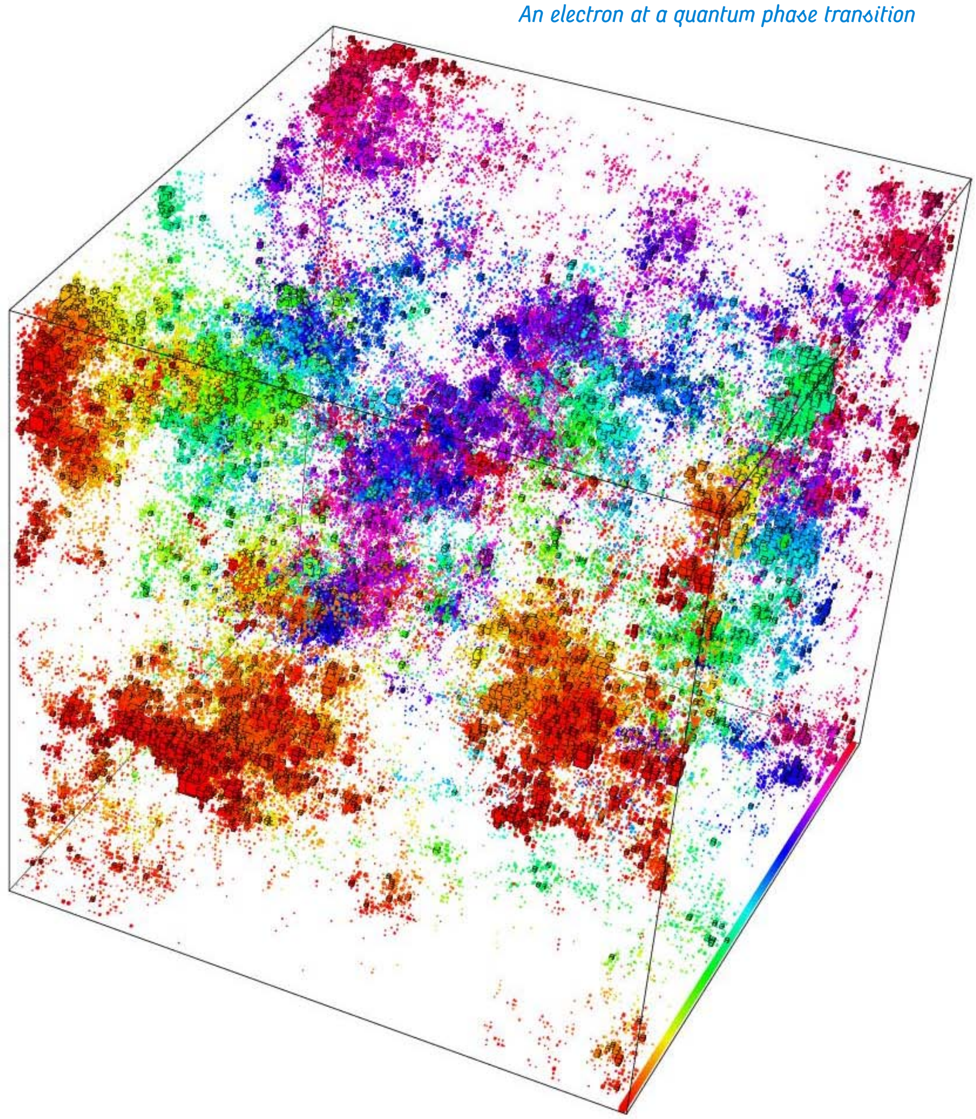
But solving disordered quantum models physics problems requires memory – and lots of it. That proved too much for the CSC's existing 128-processor Beowulf cluster and 62-processor task farm. Faced with new classes of memory-hungry scientific applications and ever-increasing data sets, CSC scientists and administrators knew that simply expanding the facility's existing cluster Beowulf environments would not address the next phase of their HPC needs.

"These are problems where adding more processors just doesn't provide any benefit," Roemer explains. "These are large-scale, shared-memory applications or codes that need very fast interprocessor communications and access to memory."

Because applications like these are commonplace at other UK universities, "Once we decided that we wanted a large, shared-memory system, we set out to buy the highest-performance architecture system we could find."

*– Matt Ismail, Computer Manager, Centre for Scientific Computing*

*An electron at a quantum phase transition*



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selecting a system with a shared-memory architecture would offer other pluses. "We wanted a system that could bridge our mid-range clusters with those in use at the national facilities," recalls Matt Ismail, computer manager at CSC, who says Warwick wanted to expand its collaboration with such facilities as the University of Manchester's Computer Services for Academic Research, or CSAR. The most powerful resource at CSAR is the Newton supercomputer, an SGI® Altix® 3700 system powered by 512 Intel® Itanium® 2 processors and outfitted with 1TB of memory. Warwick, he says, aimed to provide "a high level of compatibility" with 64-bit Linux® systems like Newton.

**'The highest-performance architecture'**

"Once we decided that we wanted a large, shared-memory system," says Ismail, "we set out to buy the highest-performance architecture system we could find."

Benchmark evaluations involving systems from other vendors and SGI revealed a dual-edged performance advantage for the SGI Altix. "The Itanium 2 processor outperformed the competition in our numerical computing benchmark," says Ismail, "and the fast SGI NUMAlink interconnect used in the Altix system was a huge contributory factor. Add to that the fact that many of the large HPC installations in the UK are based on Altix supercomputers, and the choice was easy."

So, it turns out, was installation of the new 56-processor, 112GB Altix 3700 system and 4TB SGI® InfiniteStorage TP9500 disk array. "This was the easiest installation I've ever worked on," says Ismail, no stranger to HPC and Linux system deployment and management. "The guys literally turned up, wheeled the hardware in, and turned it on. There wasn't much more to it than that."

Ismail, who holds a doctorate in chemistry and previously was a research fellow at Warwick, also finds managing the Altix system management to be simple compared to Linux clusters: "It's like comparing the administration of one machine to administering, say, a few hundred. It's an order of magnitude easier to work with a system like Altix than a Beowulf cluster."

The Altix advantage has made all the difference for researchers like Roemer, who recently used 107GB of the system's memory to run a diagonalization of a huge, so-called sparse matrix – a numerical analysis matrix populated mostly by zeros. Three years ago, researchers like Roemer spent weeks computing a matrix measuring 1 million by 1 million numbers in size. This now takes just hours on the Altix, and Roemer and his research team can now achieve a matrix size 4000 times that size within days. It is the largest diagonalization of its kind ever achieved.

The benefits aren't limited to quantum physics. In the field of magnetohydrodynamics – or the interaction of magnetic fields and electrically conducting media, such as plasmas or molten metal – researchers at Warwick are working to create large-scale simulations of the sun's corona. In doing so, they hope to learn more about how solar weather effects the earth's magnetic field.

While not as memory-hungry as some applications – current computations require only about a dozen Gigabytes of memory – these adaptive codes redistribute themselves across processors that must communicate efficiently.

### Proven track record

"Interprocessor communication speed is vital here," explains Roemer, who points out that even when only a single processor on the Altix is used for computing these problems, the overall Altix system still performs 40 times faster than the older CSC's Beowulf clusters.

Helpful, too, is the Altix system's proven track record and reliable 64-bit, industry-standard implementation of Linux. "I find it reassuring to buy something from a company that has software expertise and is reliable," says Roemer.

"Too many vendors take commodity hardware and they just 'put the Linux on,'" he says. "But with Altix and SGI ProPack, we're running an optimized version of a standard Linux implementation. As a result, things work the way you think they should work." The CSC plans to move to Novell® SUSE® Linux® Enterprise Server 9 (SLES9), now that SLES9 also supports ProPack, an SGI toolset that includes capabilities and performance improvements ideal for enabling Altix users to solve their biggest compute and data problems.

As pleased as Warwick researchers are with their new Altix and SGI storage solution, they recognize that their resource needs won't stand still. "A key advantage to the Altix is that we can scale it in any direction we need to," says Ismail, who points out that Altix supports independent scaling of processors, memory, and I/O. With SGI Altix systems supporting up to 512 Intel Itanium 2 processors in a single

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system image – and thousands more in an HPC supercluster – Warwick's CSC has plenty of computing headroom.

The university is also laying a foundation for possible future growth in its storage environment. Currently used as a direct-attached storage resource for the Altix server, the SGI TP9500 disk array can grow from its current 4TB capacity to 32TB in a single system. "We have people who work with the National Center for Atmospheric Research in the U.S.," notes Roemer, "and soon we're expecting delivery of 3TB of atmospheric data."

Roemer says physics researchers at Warwick reviewing wide-angle surveys of the universe are also adding to the storage demands. Studying images taken every second, they try to determine what changes occur across a specific time domain. "These studies require storage of dozens of terabytes," he explains.

The TP9500, says Ismail, may someday become the backbone of a storage area network (SAN) incorporating SGI InfiniteStorage shared filesystem CXFS™, which would provide researchers with instant data access and sharing among systems on the SAN without having to create multiple copies of large, multi-terabyte data sets.

That's just the kind of forward thinking that could help researchers at the University of Warwick continue to scale their research – from the quantum physics that may give birth to new miniature processors, to a greater understanding of the infinite expanse of space.



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