INDUSTRY BRIEF

Faster Results, More Science

Large Memory Systems for Science

Research environments today require significant amounts of computing power to analyze and simulate complex phenomena. And as earth and physical scientists push the boundaries of research, powerful systems are required that combine not only fast processing but very fast data access. The **SGI® Altix UV®** high performance computing system is designed specifically for large, data-intensive problems, to support physicists, earth scientists and others to more rapidly simulate processes and correlate large amounts of experimental data.

Altix UV is a shared memory server, which means that all processing cores can directly address all memory in the system. Combining up to 256 Intel® Xeon® processors 7500 series (2048 cores) in a single OS instance, Altix UV provides applications the ability to address up to 16TB of memory to support unprecedented simulation complexity and resolution. In addition, Altix UV runs standard off-the-shelf Linux®, so that application developers can seamlessly move their scalable software from a Linux based laptop to a full Altix UV 1000 system and enjoy tremendous speedups. The maximum memory that can be installed in Altix UV is about 8000 times more than on a typical laptop, and about 100 times more than on a standard 2 socket server.

Key to SGI Altix UV performance and scalability is the SGI® NUMAlink® interconnect fabric. In addition to supporting shared memory programs, SGI has implemented a Message Passing Interface (MPI) Offload Engine that accelerates even cluster applications that are by nature distributed and that have significant amounts of communication between cores. Altix UV supports many types of multi-core development models, including MPI, OpenMP, Shared Memory (SHMEM), and Partitioned Global Address Space (PGAS) languages.

SGI believes that for most scientists, the focus should be on science, not the difficulties of distributed programming APIs or the management of complex computer systems. The Altix shared memory architecture enables easy installation and administration of a single system, while SGI's data management solutions simplify the storage and archiving of large data sets.

Altix UV can be easily integrated into an existing datacenter environment as well, where it can serve as a "super node," supporting applications which are too demanding for less capable "thin node" servers.

Altix UV has been designed to work with the latest acceleration technologies for even faster simulations. For applications that would benefit from GPGPUs, SGI offers the NVIDIA Tesla products which can be easily integrated into the Altix UV environment.

Customers utilizing the Altix UV: COSMOS, PSC, HLRN, NCSA

The Altix UV is available in 3 model options.

- **Altix UV 10** – In a 4U rackmount form factor, Altix UV 10 packs up to four processors (32 cores), 64 DIMM slots and ten I/O expansion slots. With up to 1TB of shared memory, Altix UV 10 is ideal for a diverse set of technical computing and Enterprise applications.

- **Altix UV 100** - Addresses the mid-range market based on an industry-standard 19" rackmount 3U form factor. Altix UV 100 scales to 96 sockets (768 cores) and 6TB of shared memory in two racks. Altix UV 100 delivers up to 6.9 teraflops of compute power in a single system image.

- **Altix UV 1000** - For maximum scalability, Altix UV 1000 ships as a fully integrated cabinet-level solution with up to 256 sockets (2,048 cores) and 16TB of shared memory in four racks. Altix UV 1000 delivers up to 18.6 teraflops of compute power in a single system image.

Shared memory systems are ideal for a wide range of scientific applications where large amounts of data need to be accessed quickly and without the complexity of programming for a distributed environment. By utilizing memory which has much faster access than rotating disk drives (3 orders of magnitude), entire workflows can be accelerated and new science and discoveries can be made. Increased physics, model resolution and data gathering are all simplified on a system with a large shared memory.

For more information, visit www.sgi.com/altixuv.

INDUSTRY BRIEF

Customer Focus: COSMOS

COSMOS CONSORTIUM
UK National Cosmology Supercomputer

BACKGROUND

The UK Computational Cosmology Consortium (COSMOS) based at the University of Cambridge, has selected SGI® Altix® UV 1000 to support its research. Altix UV will help cosmologists answer questions at the foundation of our understanding of how the universe came to be, its makeup, how it has evolved to the present and what the future holds.

The COSMOS team is led by Professor Stephen Hawking, who won global acclaim with his 1988 book "A Brief History of Time," an account of the origins of the universe, and who is renowned for his work on black holes, cosmology and quantum gravity. He was the Cambridge University's Lucasian Professor of Mathematics, a position once held by Newton and one he had held since 1979.

The system that COSMOS recently purchased contains the following major system components:

- 768 cores Intel® Xeon® processor 7500 series
- 2TB memory
- 64TB SGI® InfiniteStorage IS4100
- Water cooled
- SGI Software-SGI ProPack7 and SGI Management Center

COSMOS chose Altix UV because the system meets COSMOS's requirements for high performance, scalable, big-memory supercomputing to facilitate vast amounts of data analysis. This allows simulations to be performed with more resolution than ever before and incorporating more advanced physics theory.

> *"I'm very pleased with the UV - performance is outstanding, at least on the small core count that we have at the moment. Its performance is 5 times higher than good old SGI Altix 4700 on well polished pure MPI code that we have (Gadget2, unmodified), and about 30% better than our main competitor (HPCS Darwin, so far). OpenMP performance is too good to be true - I need more testing to believe the numbers." Andrey Kaliazin, system administrator at DAMTP, (lab of Professor Stephen Hawking) University of Cambridge.*

SGI is collaborating with COSMOS so that Altix UV, with its ease-of-use and rapid time-to-solution, begins contributing to research findings as quickly as possible. Collaboration efforts

include: code porting to Altix UV platform, applications knowledge transfers between SGI engineers and COSMOS users, parallel programmer support and end-user training. SGI engineers will also provide dedicated support to COSMOS researchers in strategic projects.

MEETING THE COSMOS CHALLENGE

The COSMOS consortium goal is to enable UK researchers to maintain international leadership as they advance the confrontation between fundamental and observational cosmology. In addition, SGI engineers have been training the COSMOS developers on how to optimize applications for the Altix UV architecture.

Solutions were needed for several major strategic projects, such as the Planck satellite analysis codes. One of these requirements was for the large simulation requirements of theoretical ideas and then comparison with vast new observational data sets. The technical solution was clear, a new Altix UV system that would support the wide range of workloads presented to the consortium members (8 universities including Cambridge). As the details of the current and anticipated workload became known, the SGI team was able to demonstrate the benefits of Altix UV, showing that a large shared memory system would enable the research team to run their simulations faster and with greater complexity than ever before.

"The new Altix UV system gives us a strategic advantage as we seek to advance the confrontation between fundamental and observational cosmology," said Professor Paul Shellard, director, COSMOS. "This flexible, scalable and cost-effective architecture will ensure that COSMOS maintains international leadership."

For more information about COSMOS, visit:
http://www.damtp.cam.ac.uk/cosmos/

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Customer Focus: Pittsburgh Supercomputing Center

Since the beginning of February 2010, PSC has been working to build and run important applications in climate, weather, chemistry, materials science and physics using Altix UV. The center has also tested kernels representing unique applications in graph-based informatics, an area in which Altix UV is expected to excel. Ongoing work at the center will target additional high performance computing (HPC) applications, including biology and astrophysics.

PSC's Altix UV 1000 System

- 4096 cores Intel® Xeon® processor 7500 series
- 32TB memory
- SGI Software - SGI ProPack7 and SGI Management Center

The Pittsburgh Supercomputing Center is a joint effort of Carnegie Mellon University and the University of Pittsburgh together with Westinghouse Electric Company. Established in 1986, PSC is supported by several federal agencies, the Commonwealth of Pennsylvania and private industry, and is a partner in the National Science Foundation TeraGrid program.

> *"PSC is pleased to have had early access to Altix UV," said Dr. Nicholas Nystrom, director of Strategic Applications at PSC. "Early results are compelling; Altix UV is living up to its promise as a highly productive, performance-oriented, shared memory supercomputer, ideal for PSC's very advanced applications."*

"Because of the extraordinary memory size and relative ease of programming made possible by the Altix UV shared-memory structure, scientists and engineers will be able to solve problems that were heretofore intractable," said PSC scientific directors Michael Levine and Ralph Roskies in a joint statement. "For many research communities — including data-analysis and many areas of computer science — it will open the door to use of high-performance computation and thereby expand the abilities of scientists to ask and answer questions."

The 4,096 processor cores and 32 terabytes of shared memory are interconnected using SGI's next-generation high-bandwidth, low-latency NUMAlink 5 interconnect. This interconnect has specialized features that enable scalable shared-memory or message-passing applications to run with higher levels of parallel efficiency so that researchers can assign more processor cores simultaneously to the same task. This allows researchers to address larger problems and solve them more quickly

Through close collaboration with SGI engineering, PSC has successfully accomplished runs on up to 512 cores. PSC is also studying in-depth performance analysis of Altix UV and exploring Altix UV's potential for implementing high-productivity programming models. PSC will integrate the new system into the TeraGrid, the NSF program of comprehensive cyberinfrastructure, greatly increasing the capability available for U.S. science and engineering research.

"PSC has a long and successful history in working with computer manufacturers to take the earliest available hardware and software systems and help them evolve into mature production platforms," said Michael Levine, scientific director at PSC. "Our exciting work with Altix UV is the latest of these ventures."

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Customer Focus: HLRN

HLRN (North German Supercomputing Alliance) is a consortium of the six North-German states Berlin, Bremen, Hamburg, Mecklenburg-Vorpommern, Niedersachsen and Schleswig-Holstein, established in 2001. HLRN covers the huge demand for computing resources in the domains of environmental research, climate and ocean modeling, engineering applications like aerodynamics and ship building, as well as in fundamental research of physics, chemistry, and the life sciences.

Altix UV will be primarily used for memory-intensive challenges found in materials science (using density functional theory with hybrid functionals), crystallography, astrophysics, computational fluid dynamics and computational fluid dynamics and meteorology. Our scientists are looking forward to making new discoveries with their new Altix UV systems."

HLRN's Altix UV 1000 System

- 4352 cores Intel® Xeon® processor 7500 series
- 18TB memory

> *"In contrast with other systems, Altix UV gives us the unique possibility to handle our user demand for varying ratios of memory per core. This gives us more flexibility in assigning jobs to the system than was previously possible. With a total of 4352 cores and 18TB of main memory the Altix UV systems at HLRN will be among the largest scale-up systems in the world."*

Customer Focus: NCSA - National Center for Supercomputing Applications

The National Center for Supercomputing Applications (NCSA), located at the University of Illinois at Urbana-Champaign, provides powerful computers and expert support that help thousands of scientists and engineers across the country improve our world. With the computing power available at NCSA, researchers simulate how galaxies collide and merge, how proteins fold and how molecules move through the wall of a cell, how tornadoes and hurricanes form, and other complex natural and engineered phenomena.

NCSA's Altix UV 1000 System

- 1536 cores Intel® Xeon® processor 7500 series
- 18TB memory
- 170TB storage
- 13.5GB/s I/O bandwidth

Ember, as the system is called, is configured to run applications with moderate to high levels of parallelism (16-384 processors).

> *"There has been a clear increase in the demand for shared memory resources," said TeraGrid forum chairman John Towns, whose persistent infrastructure team at NCSA will deploy and support Ember. "Allocation requests for shared-memory systems have consistently exceeded the available resources—by as much sevenfold in a recent review of requests—and have been followed by a series of results highlighted in TeraGrid publications. We know Ember will be an essential tool for science and engineering research."*

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