A Top500 and Green500 Supercomputer

Based on SGI Rackable Standard-Depth Servers and AMD Opteron™ Processors

Key Facts

Organization:
Université de Sherbrooke

Location:
Province of Québec, Canada

Industry:
Educational Institution

Located in the Province of Québec, Université de Sherbrooke is a French-speaking institution that offers an academic education that is recognized and valued around the world. With a diverse student population, Université de Sherbrooke employs innovative teaching methods along with cutting-edge research technology. This technology now includes the fastest supercomputer in Canada: the Mammouth supercomputing cluster based on SGI® Rackable™ 2100 Series standard-depth servers, powered by AMD Opteron™ 6100 Series processors.

Mammouth: Canada's Fastest Supercomputer

As a national and international computing resource, Mammouth is used by researchers all over Canada as well as from around the world through collaborations. A general-purpose high-performance computing (HPC) cluster, Mammouth hosts highly diverse fields of exploration including the natural sciences, engineering, and health sciences. The cluster is run by the Center for Computational Science within the IT Services division of Université de Sherbrooke. The center provides staff to operate and maintain the system, install software, and offer programming assistance to help researchers utilize the cluster. The Mammouth acquisition was funded through federal and provincial governments (Compute Canada and the Canada Foundation for Innovation [CFI] as well as the Province of Québec).

Université de Sherbrooke is no stranger to powerful supercomputers, and hosted the most powerful supercomputer in Canada in 1995, 2000, and from 2005 through 2008. The school has considerable experience with clustered computing, having built their first HPC cluster in 1992 based on the IBM RS6000 system, subsequently an SGI® Origin™ 2000 system was added in 1998. The first SGI cluster with x86 processors was deployed in December 2008, and featured 2,464 cores.

With over 15 times the core count of that first SGI x86 cluster, Mammouth was named to the Top500 list of supercomputer sites (www.top500.org) on November 15, 2011 – as the most powerful computer in Canada, and the 41st most powerful supercomputer in the world at that time. Subsequently, Mammouth was also named as number 63 on the November 2011 Green500 list (www.green500.org), showcasing not only the system's computational power, but also its leadership as an efficient and ecologically responsible system. A part of the national "High Performance Computing Platform" coordinated by Compute Canada, Mammouth allows all Canadian researchers to access these cutting-edge computing resources, regardless of their home institution.

Built by SGI®, Powered by AMD

The Mammouth cluster is comprised of 1,600 individual servers. Fast, efficient, and economical SGI Rackable 2100 Series standard-depth servers powered by 12-core AMD Opteron 6100 Series processors offer 39,648 cores to serve a broad range of computational tasks. Together, the cluster systems provide 57 terabytes of memory to support both computationally-intensive and memory-intensive jobs.

According to Alain Veilleux, Director of the Center for Computational Science, the cluster is deployed using QDR InfiniBand in a fat tree topology. A small portion of the cluster fabric is fully non-blocking to accommodate highly parallel jobs, with the remainder of the cluster configured for a 3.5-to-1 blocking factor. In addition to InfiniBand, Ethernet switching is also deployed for management, and to accommodate some applications that require IP networking. A half-petabyte Lustre file system provides storage for the cluster and will be increased over time.

Performance, Efficiency, Density, and Price/Performance

"Low cost and high efficiency were the goals," Veilleux says. "Our performance criteria were expressed with a benchmark as a part of an RFP, and SGI, AMD, and switch vendors worked together to make sure their proposals met our needs. Density and price/performance were also critical evaluation factors for the cluster acquisition."

SGI Rackable Standard-Depth 2100 Series servers equipped with 12-core AMD Opteron 6100 Series processors answered these needs. These systems offer very compelling price/Gflop ratios, and also highly competitive Gflops/TDP Watt performance. By providing more cores and requiring less electrical power per core, individual nodes are capable of the higher performance needed by heavily parallel HPC applications, and the complete system is also highly efficient.

The Green500 listing speaks to the outstanding efficiency of the system itself, yet Université de Sherbrooke went even further to drive additional environmental efficiency. Enclosed cold aisles with variable speed fans enable high density and efficiency for the cluster. In addition, waste heat from cooling the cluster is reused to defer other energy costs. Because of Québec's cold climate, chilled water is first used to cool the data center, and the warmed water is then circulated to help heat a wing of the science faculty building.

More Cores per Node Yield Greater Simulation Resources

Despite the size and performance of the cluster, it is easily managed by staff of the Center for Computational Science, who also support all of the center's resources and users. Given the research focus of the cluster, most of the large users employ custom codes rather than commercial applications. Staff work with researchers and users to tune their codes to extract maximum benefit from the large number of cores provided by AMD Opteron 6100 Series processors, or to balance access to memory. States Veilleux, "As the fastest supercomputer in Canada with both Top500 and Green500 listings, our performance and efficiency goals were definitely met. Best of all, the cluster has been running at almost full capacity since the first week of production, ensuring that this valuable resource is put to good use serving research needs."

A Functional Cluster in Only Six Days

The entire Mammouth system was built, cabled, staged, and tested in Chippewa Falls, Wisconsin at the SGI manufacturing and server engineering facility, thus reducing the opportunity for on-site configuration errors and delays, and easing the delivery of a large and complex cluster. After loading a software stack to test all of the networking, SGI delivered 25 fully built and cabled racks to Université de Sherbrooke via a specialty mover. Only 13 hours later, the cluster was powered on to generate a thermal load for the room, allowing the install team to run through a test suite and to complete the cabling between the racks and the existing data center networks. A complete spares kit was provided – sized specifically for the cluster – to facilitate rapid repairs and avoid delays. The completed, fully-functioning cluster was handed over to Université de Sherbrooke staff within only six days from initial delivery.

"Once on site, this was simply the fastest and most efficient installation that I've ever seen. We went from an empty room to an operational cluster running Linpack in only six days."

Alain Veilleux
Director of the Center for Computational Science
Université de Sherbrooke

About Université de Sherbrooke

Université de Sherbrooke is located in Sherbrooke, in the southern portion of Québec, Canada. A French-speaking institution, Université de Sherbrooke employs over 6,700 people, including 2,300 professors. The university is host to more than 37,000 students, with over 1,600 foreign students from over 100 countries worldwide.

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