SHARCNET™

SHARC BYTES
newsletter

Summer 2008 VOL. 6 ISSUE 1

Neutrinos by the Numbers

RESEARCHERS AT THE SUDBURY NEUTRINO OBSERVATORY (SNO) ARE DELVING DEEPER INTO THE WORLD OF NEUTRINOS WITH THE USE OF SHARCNET

BY MATTHEW DICICCO, STUDENTS PROMOTING AWARENESS OF RESEARCH KNOWLEDGE (SPARK) PROGRAM AT THE UNIVERSITY OF GUELPH

With no electric charge, and very little mass, neutrinos are elusive. They interact weakly with matter, making them difficult to detect.

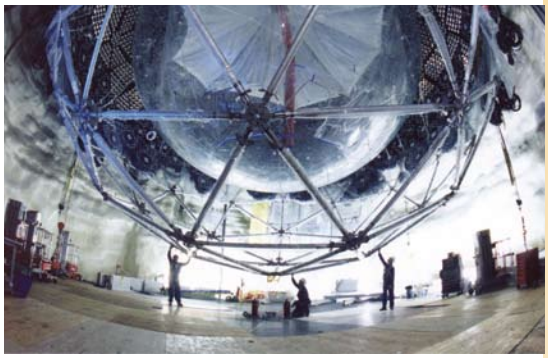
But neutrinos are thought to be vital to the understanding of the universe. It's believed millions of neutrinos exist per cubic foot, filling the universe. So even with the smallest mass, they can induce gravitational effects in a huge way.

Neutrinos are emitted by radiation sources. They're known to exist in three types related to three different charged particles – the electron-neutrino, muon-neutrino and tau-neutrino. Transformations called neutrino oscillation occur between them.

Dr. Melin Huang, Department of Physics, Laurentian University, at the SNOLAB, is studying a specific oscillation parameter, theta_13. The name comes from the fact that it is related to the transformation between the first generation electron-neutrino, to the third generation tau-neutrino. She believes further study of this oscillation parameter could have profound effects on particle physics understanding.

"Without theta_13, the phenomena employed to describe neutrino oscillation behavior is incomplete and could lead to misinterpretations in the particle physics world," says Huang.

New technology has made it possible to model and detect the three different types of neutrinos accurately, and how they oscillate. Theta_13 is the only missing parameter in the oscillation equation. It's usually overlooked, being the smallest and hardest to assess.



SNO detector during construction

Currently, only a range exists for the parameter. With this value accurately measured, however, the neutrino model would be complete and could lead to future research in particle physics.

Using the modeling power of SHARCNET, Huang is trying to get a smaller range of numbers, so the oscillation parameter value can be made more precise. This involves difficult computational analysis of 3-D space. SHARCNET allows her to compute millions of samples at one time, and produce a better estimate of the small parameter locations. Hopefully, that will lead to a solid number for the oscillation parameter of theta_13.

Dr. Clarence Virtue, Department of Physics at Laurentian University, says that theta_13 is a fundamental value of nature, possibly having implications in cosmology and particle physics. He believes Huang's research could be a crucial step towards solving such physics problems as what happened to all the antimatter – the mirror image of ordinary matter – in our world.

"Some of the greatest ongoing problems in particle physics may be solved by taking a closer look at theta_13," says Virtue.

Research funding is provided by the Natural Sciences and Engineering Research Council and Laurentian University.

in this issue:

Message from the Chair of the Board

Ted Hewitt,
Chair of the Board

"Compute Canada represents a major step forward in moving from a regional to a national HPC collaboration"

On behalf of the Board of Directors, it is my pleasure to welcome Susan Baldwin to the HPC community. She was recently announced as the new Executive Director for Compute Canada, effective September 1st. Susan brings a wealth of leadership and experience in developing business plans, coordinating distributed initiatives and building effective partnerships which will be extremely valuable as Compute Canada builds a strong and effective national organization.

Working in collaboration with Canada's seven university-based HPC consortia, Compute Canada works to ensure that Canadian researchers have the computational facilities and expert services necessary to advance scientific knowledge and innovation. According to their website, computecanada.org, Compute Canada represents a major step forward in moving from a regional to a national HPC collaboration. It also fulfills one of the highest priority recommendations of the C3.ca-sponsored Long Range Plan for HPC. Compute Canada aims to further build a shared distributed HPC infrastructure to best meet the needs of the Canadian research community, creating an environment that fosters and enables new research insights and advances. We look forward to working with Susan and the other consortia to help realize the vision of Compute Canada!

On the provincial front, the Ontario High Performance Computing Council was asked by the Ministry of Research and Innovation to make some updates and modifications to Ontario's HPC strategic plan. The final version is currently being completed and we are poised to release the provincial HPC research and development capacity plan in the coming months.

More locally, there are some changes on the SHARCNET Board to report. I am pleased to have the following individuals recently join the Board: Dr. Steven Liss, Interim Vice-President, Research, University of Guelph; Dr. Rajnana Bird, Vice-President, Research, University of Windsor; Dr. Murat Tuncali, Chair of the Department of Computer Science and Mathematics, Nipissing University; Dr. Gyles Iannone, Associate Vice-President, Research, Trent University; and Dr. Mark Daley, Associate Professor, Computer Science, The University of Western Ontario and SHARCNET's researcher representative at large. For those who have recently stepped down from the Board, I want to thank and formally acknowledge the valued contributions provided by: Dr. Alan Wildeman, formerly of University of Guelph; Dr. Keith Taylor, University of Windsor; Dr. Andrew Dean, formerly of Nipissing University; Dr. Jim Parker, Trent University; Dr. Deborah Stacey, previous researcher representative from University of Guelph; and Dr. Andrew Bjerring, President and CEO of CANARIE. The collective wisdom and experience of this group has been instrumental in SHARCNET's continued success.

As is normal at SHARCNET, the staff have been very busy over the last several months on a number of initiatives, including training, outreach efforts and new research programs. I encourage users to read through the SHARCNET newsletter and browse the website to get a better sense of the activity and progress that is being made.

W. E. (Ted) Hewitt, Ph.D
Chair, SHARCNET Board of Directors and Vice-President
(Research & International Relations), The University of Western Ontario

Scientific Director's Message

I am pleased to present another edition of SHARC Bytes and provide an update on recent activities and developments.

SHARCFest 2008, an outreach campaign of open houses, training events and symposia to help educate the broader community on the uses and importance of high-performance computing to research, was held over the entire month of May and early June. The outreach campaign included over twenty events, scheduled across most SHARCNET sites and attracted hundreds of students, researchers, Site Leaders and staff. The culmination of SHARCFest was our premier training event, Summer School 2008, held at York University, June 2-6, 2008, aimed at the development of high performance computing skills and knowledge. SHARCNET Research Day 2008, was held in conjunction with the Summer School on June 6, 2008 and consisted of invited talks and posters to provide individual experiences and insights on using SHARCNET to further research. Overall, we were thrilled with the community's response and plan to run another series of events next summer.

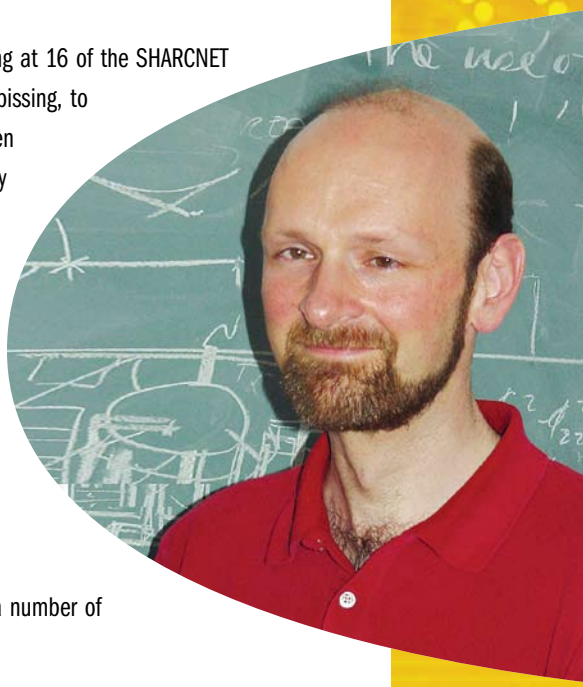
In terms of policies, SHARCNET has recently implemented a new Acceptable Use Policy and user-certification scheme, which will streamline new account procedures and help ensure efficient use of our systems.

The new "Acceptable Use Policy, Guidelines and Principles" document was approved by the SHARCNET Board in June. The new document replaces the somewhat ad hoc previous arrangement that referenced the Acceptable Use Policies (AUPs) of all partner institutions with a more streamlined common policy that will hold across all SHARCNET facilities. All users need to read and accept the new AUP, which can be viewed at: https://www.sharcnet.ca/my/security/accept_aup

As many of you will be aware, SHARCNET has also developed a simple certification procedure to ensure that users acquire a degree of expertise that is appropriate for the level of resources to which they have access. This helps us demonstrate to our funding agencies that their investments are used effectively and is one mechanism that helps ensure that our heavily used, shared systems remain useful for the community as a whole. There are three certification levels, zero (the entry level), one (the default level), and two (the highest level). Starting in September, every user will be assigned to one of these levels based on their demonstrated HPC competence. All existing users will be grandfathered to level one; all new users will be assigned to level zero. New users will be required to attend our introductory seminar and complete a brief quiz in order to graduate to level one. Level one users must request promotion to level two by sending e-mail to help@sharcnet.ca. Level two will be restricted to experienced users and users who can demonstrate both a need and an ability to efficiently use SHARCNET's high performance computing resources. This process is also described online at: http://www.sharcnet.ca/Facilities/certification.php

One final policy change relates to commercial software that can be requested for our systems. Previously, a small yearly charge was levied for each group wanting to access licensed commercial software. Effective January 1st, 2009 this charge will be removed. The process for deciding which software will be supported on our systems is described in the new policy at: https://www.sharcnet.ca/my/systems/software09

We now have AccessGrid rooms running at 16 of the SHARCNET partner sites, with the final one, at Nipissing, to be added shortly. Some sites have seen the addition of a second room, namely Windsor and a soon to be completed second room at Guelph. These rooms continue to be in heavy demand for training, graduate supervision, graduate courses, and numerous SHARCNET management and technical meetings. They also allow SHARCNET users to participate in the Coast-to-Coast seminar series.



Hugh Couchman, Scientific Director

In addition to AccessGrid expansion, a number of other system changes are underway:

- SHARCNET's older alpha systems are being decommissioned on January 1, 2009 to make room for newer equipment
- A new GPU (Tesla S870) server (tope.sharcnet.ca) has been installed at Laurier

Continued on page 4

SHARCFest event underway

"The SHARCFest outreach campaign included over twenty events, scheduled across most SHARCNET sites and attracted hundreds of students, researchers, Site Leaders and staff."

Scientific Director's Message, continued from page 3

- the Mako cluster (for training and testing) at Guelph has been upgraded
- the Experimental cluster at Brock has been ordered
- SHARCNET recently issued an RFP for a general purpose parallel cluster and associated storage, with a response deadline of October 1st, which we hope to have operational in early 2009

If you've been following the SHARCNET website or reading e-mails to the "general" e-mail list, you will also be aware that a call for proposals for Round IX Fellowships and Dedicated Resources was issued over the summer, with a deadline of September 30, 2008. While we expect to run another Fellowships round in the future, there is a very good chance that our next round may be our last, unless we are able to secure new funding. For those of you who are interested in applying for a Fellowship, make sure you take advantage of these rounds while the funding is still available!

Earlier this year, SHARCNET introduced the new Dedicated Programming Support Competition. This new research program, which grew out of our strategic planning, provides support for computational projects of exceptional potential that will have lasting impact and value and that require significant support from SHARCNET to proceed. A central goal is to enable projects from disciplines that are traditionally not major users of HPC. With one round completed this past summer, a further round may be announced in 2009 dependent upon demand and available resources. See https://www.sharcnet.ca/my/research/programming/ for more information.

The annual SHARCNET user satisfaction survey was conducted a few months ago. This survey was introduced last year in consultation with the user community, Site Leaders and the Researcher Interaction Committee. The results are currently being tabulated and reviewed. A summary of the survey results will be posted soon, via the SHARCNET webportal.

Whether you are a first-time user of SHARCNET or an experienced user, I hope that you find the newsletter a valuable source of information. As always, if you have any questions about these items or any other issues at SHARCNET please do not hesitate to contact me or SHARCNET staff.

Hugh M.P. Couchman
SHARCNET Scientific Director
Fellow, Canadian Institute for Advanced Research
Professor, Physics and Astronomy, McMaster University

Shedding Light on Dark Matter

SUPERNOVAE SHOCK WAVES USED TO EXPLAIN DARK MATTER DISTRIBUTION IN GALAXIES

BY ANUPRIYA DEWAN, STUDENTS PROMOTING AWARENESS OF RESEARCH KNOWLEDGE (SPARK) PROGRAM AT THE UNIVERSITY OF GUELPH

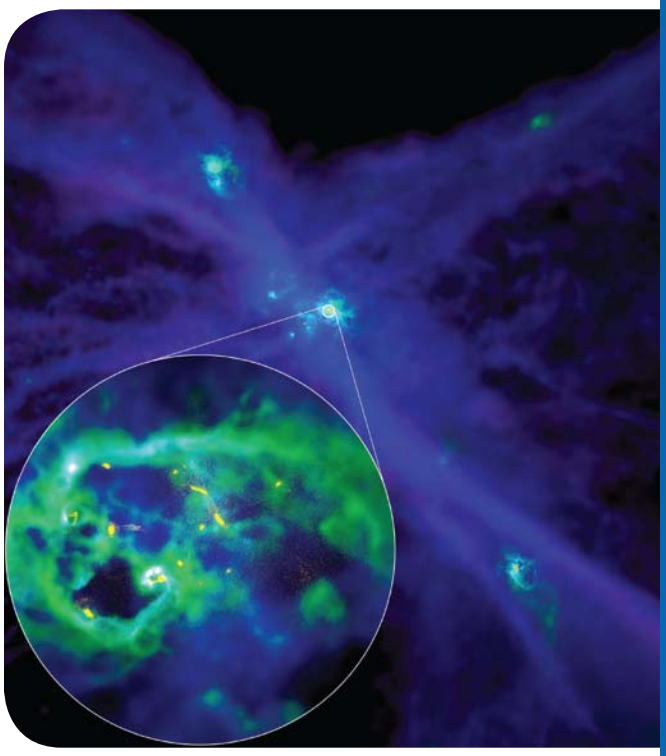
The Cold Dark Matter Theory is making a louder clamor in the corridors of cosmology, thanks to McMaster University researchers and the computing strength of SHARCNET.

Sergey Mashchenko, Research Associate in the Department of Physics and Astronomy, was able to immerse himself in the mystery of the dark matter missing from the centres of galaxies. His theoretical models attempt to explain why observations show less dark matter in the centres of galaxies than Cold Dark Matter cosmology would dictate. He believes that while galaxies are being formed, a great deal of gas is accumulated in the centres of galaxies. Also, during this time, supernovae (exploding stars) send shock waves through the gas. These shocks push gas around, resulting in less dark matter in the centre of the galaxy.

"We are trying to determine how supernovae affect the dark matter distribution in galaxies," says Mashchenko. "We showed that 'sloshing' back and forth of regular matter (gas) would kick most of the dark matter out. This explains why dark matter is not detected in large quantities at galactic centres."

In the Cold Dark Matter Theory, dark matter – matter that cannot be seen and is only observed by its gravitational pull on other objects – is the dominant mass component of all galaxies, and is glue that holds galaxies together via gravity forces. According to the theory, soon after the Big Bang, the uniformly distributed dark matter in the expanding universe became increasingly more clumped because of gravity forces. These clumps later became galaxies which, according to previous cosmological simulations, should have a significant concentration of dark matter at the centre.

However, observations did not match the theory. The observed distribution of dark matter is not strongly peaked in the centres of galaxies, says Mashchenko. There is no generally accepted solution to this problem. As a way out, some scientists proposed the Cold Dark Matter cosmology is wrong and needs to be modified or even replaced with a new theory.



Dwarf galaxy forming one million years after the Big Bang

But Mashchenko and his team of researchers believe the theory is sound and doesn't need to be modified. Instead, they focused on factors previously unexplored by scientists. They looked in detail at how galaxies are formed, with the focus on 'sloshing' of gas around star forming regions, the effect which had not been taken into account in previous simulations. Mashchenko believed this was an important factor, and used SHARCNET to test his hypothesis.

Using the SHARCNET supercomputers, the team modeled a forming galaxy in high resolution. By analyzing the modeled galaxy, they found that their predictions were accurate. They had successfully reconciled observations and theory, bringing us one step closer to explaining how the universe works.

"It actually doesn't surprise me that cosmology (the theory which tries to explain the whole universe) still has some unresolved issues. We were able to solve one of these lingering problems," says Mashchenko.

The study was published in *Science*. Others involved in this research were James Wadsley and Hugh Couchman. Part of the funding for the research was provided by SHARCNET.

More Funds for SHARCNET Research Chairs

"The SHARCNET Chairs Program is designed to enable strategic faculty hiring and to attract world-renowned experts in a variety of fields to SHARCNET institutions."

SHARCNET is pleased to announce the results of the Round IV competition for SHARCNET Research Chairs, targeted at non-traditional HPC disciplines and those that will build expertise in HPC tools and techniques. In September 2008, the Board of Directors approved the allocation of two new SHARCNET Research Chairs as follows:

Institution	Research Area
University of Waterloo	Geomatics
University of Ontario Institute of Technology	Interactive and Collaborative Scientific Visualization

This allocation allows the institutions to begin recruitment efforts for a suitable Chair candidate. Each award is conditional on final approval of the Chair candidate by the SHARCNET Chairs Selection Committee and the Board of Directors.

About the SHARCNET Chairs Program

The Chairs Program is a cornerstone of SHARCNET's mission. Its goals are to enhance research requiring high performance computing (HPC), to build a community of expertise in HPC amongst its partners and to attract world-class researchers. The program provides bridge salary funding for tenure-track faculty positions for up to two years. SHARCNET Research Chairs are expected to enhance research using HPC and to promote interdisciplinary studies and interactions among departments and universities. The program is intended to attract new recruits to a department or faculty.

Since July 2001, SHARCNET has provided bridge funding for 18 SHARCNET Research Chairs. Applications are evaluated by the SHARCNET Chairs Selection Committee, which includes representatives from across disciplines from the partner institutions.

SHARCNET wishes to acknowledge **Hewlett Packard** and **Silicon Graphics** for their financial contributions which support this very important research program.

Peter Forsyth
(Waterloo)

SHARCNET and SSC Host International Workshop on Computational Finance

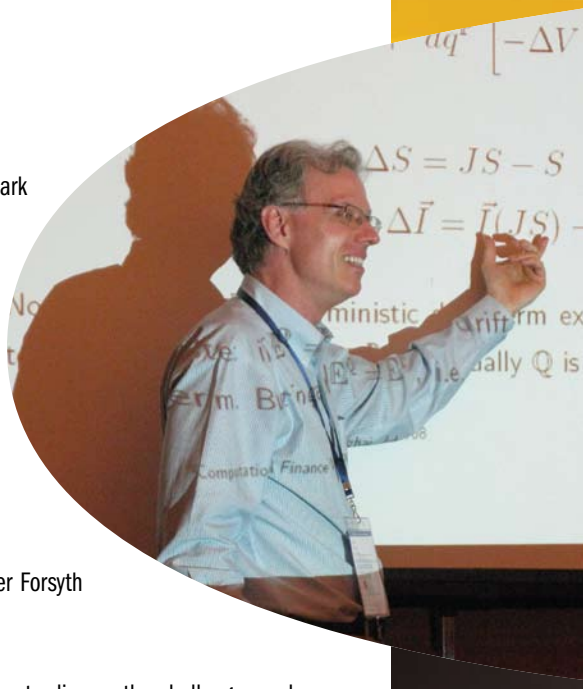
BY BAOLAI GE, HPTC CONSULTANT, SHARCNET

Shanghai, one of the largest cities in the world and now an emerging financial centre in the Far East has once again become synonymous with new opportunities. Behind the spectacular skyline of skyscrapers and the bustling commercial streets is the strong, vibrant pulse of financial activity that drives the economy. Over the past twenty years Shanghai has been home to a flourishing financial industry, as the recent influx of foreign banks and financial firms in Shanghai has enhanced the city's financial business to a level unseen since the early 1990s.

The emerging generation of practitioners and researchers in the finance industry now face the same issues and challenges as their colleagues in the west have over the past few decades. Even today, the use of high performance computers for solving financial problems still seems, to them, to be distant in practice, if not completely new in concept. This past July the Shanghai Supercomputer Center (SSC), SHARCNET, and University of Waterloo jointly organized and sponsored a workshop on computational finance in Shanghai to discuss the challenges in computational finance. By presenting recent developments in the field, the new generation of financial researchers and practitioners will benefit from current and successful international trends.

This was the first such workshop for the public in Shanghai and, according to SSC, it was met with considerable positive attention from the financial industry in China. The workshop, held at the stylish Shanghai International Convention Center, was attended by nearly fifty people from Beijing, Shanghai, Hong Kong and South Korea. Attendees, many of who were senior executives or research fellows, represented prominent financial institutions such as China Investment Capital Corp. Inc., China Asset Management Co. Ltd., China Foreign Exchange Trade Systems, Shanghai Futures Exchange, Bank of Communication, Bank of Construction, Deutsche Bank, and Morgan Stanley.

The workshop was jointly chaired by Yuan Jun, Vice Director of SSC and Thomas Coleman, Dean of Faculty of Mathematics at University of Waterloo, and former Director of Connell Theory Center.



The invited speakers included Mark Broadie of Columbia University, David Li of Credit Derivatives Group at Barclays Capital in New York (now Chief Risk Officer of China Investment Capital Corp., Inc.), Liuren Wu of Zicklin Business School, City University of New York, Dan Rosen, President of R2 Financial Technologies in Toronto and Peter Forsyth of University of Waterloo.

The objective of the workshop was to discuss the challenges and recent progress in the area of computational finance. The emphasis was on practical problem solving involving novel algorithmic approaches to large-scale and time-sensitive problems, as well as the modern use of technology–in terms of grid and cluster computing, high-end computers, and new computational finance environments. Financial areas of impact included risk computations, portfolio optimization, credit risk analytics, asset-backed securities, hedging techniques, and high-frequency data problems. There were specific topics that covered simulation and calibration of stochastic volatility, estimation of option pricing models, valuation and risk management of credit portfolios, robust portfolio management, copula functions applied to the credit portfolio problems and dynamic hedging under jump diffusion with transaction cost.

Computational finance is one of the many diverse research areas at SHARCNET. Solving practical problems that are both complex and time-sensitive requires the processing power made available only by supercomputers. This event was SHARCNET's first joint workshop with the Shanghai Supercomputer Center since the signing of the Memorandum of Agreement (MOA) in October, 2007. Ultimately, it provided the attendees with the opportunity to meet internationally established experts in a close and friendly setting to learn of and discuss new advances and issues of common interest. The joint workshop, presented by SSC and SHARCNET, has also opened a window for the public, shedding light on future possibilities enabled by high performance computing. For more information, visit http://www.sharcnet.ca/events/cfws2008

SHARCNET Outreach to the Humanities

BY GEOFFREY ROCKWELL, TAPOR PROJECT

Digital Humanities workshop underway

Mike Bauer (Western) and John Bonnett (Brock)

This past April, SHARCNET hosted a two-day Digital Humanities workshop that brought together humanities scholars that use computing methods with high performance computing experts to discuss what opportunities and challenges exist. The goals of the workshop, hosted at McMaster University, were to figure out:

- What are the opportunities for the use of HPC facilities for humanities research?
- What examples are there of good practices and research innovation?
- What are the barriers to humanists using HPC facilities like SHARCNET and how can they be overcome?
- What concrete steps can SHARCNET (and by extension other HPC facilities) take to reach out to computing humanists and to then support their research?

Twenty-five participants from SHARCNET universities and other interested organizations attended. Dean Suzanne Crosta of McMaster University introduced the workshop and Stephen Downie from the University of Illinois, Urbana-Champaign, was the keynote speaker. He talked about the use of HPC in music recognition and showed a system that took a live music stream and passed it to different genre recognizers comparing the real time recognition of music.

Geoffrey Rockwell of the TAPoR project and the programme chair called it a “great success because we were able to identify concrete activities that we can do to engage digital humanists.” A draft report and action items are available via the SHARCNET wiki at: https://www.sharcnet.ca/dh-hpc/. As a result of this workshop, Rockwell and SHARCNET’s Scientific Director, Hugh Couchman, presented “A Big Bridge: High Performance Computing and the Humanities” at the Congress of the Humanities and Social Sciences in June 2008, at UBC.

SHARCNET Helps Select Team Canada

BY PATRICK WHIPPEY, CHAIR, TEAM CANADA SELECTION PANEL

SHARCNET is not getting into the hockey business, but is rather helping a team of distinguished scientists and teachers in London select high school students from all of Canada to take their science projects to the Intel International Science & Engineering Fair. Out of forty initial applications, twenty-seven made the cut into the play-offs. From there, a series of elimination rounds were held, with teams of three judges taking on each candidate in interviews of twenty minutes each. Candidates supplied a five page report and a PowerPoint presentation. Some used their razor sharp knowledge of science and finely tuned projects to score slap-shots, placed unerringly into the corner of the net.

With sixteen places on Team Canada available, the competition for the final few places was fierce. At the end of the day, standing victorious were two students from Quebec, six from Ontario, two from Manitoba, four from Alberta and two from British Columbia. Projects raged from geometry, "The Blaschke - Lebesgue Problem Revisited"; to ecology and mercury uptake, "Insights from Elemental Analyses of Seal Claws"; to improving horse shoes, "No Feet - No Horse"; to an improved design for wheelchairs that allows the rider to get gentle exercise, "The Actuator". These students need strong motivation just to complete the application process, which can involve filling in up to six or seven different forms, all requiring signatures of various mentors, parents and scientific advisors. Graduates of this program will find completing an NSERC major grant application as simple as sending an e-mail message.

If any member of the SHARCNET Family has the opportunity to mentor a high school student in a science fair project, please take it. Participation at the level of the Canada Wide Science Fair, or the Intel International Science & Engineering Fair, changes lives, opens new opportunities and provides new focus and commitment. We all have a clear responsibility to encourage the next generation of young scientists.

The Youth Science Foundation Canada is most grateful for the support of SHARCNET, and the infrastructure provided to make the selection process possible.

Details can be found on the YSF web site: http://www.ysf-fsj.ca

Swimming with SHARCS: New Staff

We are pleased to introduce the following individuals to the SHARCNET community:

Terry McKay

Terry McKay joined SHARCNET as a Systems Administrator, based out of the University of Windsor, at the end of May. Terry received his Bachelors in Computer Science from the University of Windsor, and has been teaching Advanced Web Design there for about eight years. Formerly a head Systems Administrator for an ISP company, Terry also brings a wealth of Unix and Linux experience.

Isaac Ye

Isaac Ye, our newest HPC Programming Specialist, based out of York University, started with SHARCNET on September 2nd. Isaac is a PhD candidate for Computational Fluid Dynamics in Mechanical Engineering. His current work, which he will be defending shortly, involves the development of a parallelized Large-eddy simulation solver for turbulent reacting flows. Prior to taking up his PhD study, he worked on developing a high-throughput bioinformatics solution for gene-mining researchers at Genops Bioinformatics, Inc.

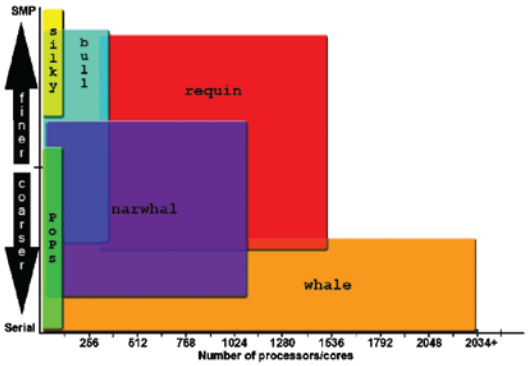
Welcome to both Terry and Isaac!

BY DAVE MCCAUGHAN, HPTC CONSULTANT, SHARCNET

Picking the Right Cluster for Your Code

When SHARCNET deployed the current iteration of hardware, it attempted to balance demands for the very highest performance hardware with the desire to have as many compute cores as possible by deploying systems with different computational and networking characteristics. Obviously if we deployed only machines on one end of the spectrum, we would either have substantially diminished processor capacity or hardware inadequate for the needs of our more demanding parallel users. The differences between the clusters may seem subtle at first glance, but this article will broaden the reader's understanding of the rationale by which the clusters were designed and explain how to select the best machine for your code to minimize the time your job sits in the queue, and provide the fastest run time to make ideal use of the resources available.

On some level, understanding parallel performance is all about communication. How frequently do the processes or threads that constitute your job have to communicate? How much time is spent doing local computation in between communication events? What volume of data is required per unit time to keep as much computation as possible occurring? As we do not have infinite time to consider every issue, this article will consider two major dimensions along which you can understand your program's behaviour.



Parallel Granularity

Granularity refers to the amount of computation that is performed between communication events. A *fine grained* parallel program performs relatively small amounts of work before requiring communication with other processors in order to continue. A more *coarse grained* program performs significant computation in between the need for communication. At the far end of the coarse grained spectrum is serial code comprised of 100% computation and requiring no communication at all.

The more fine grained your program, the greater your need to minimize communication latency and maximize bandwidth in order to minimize the idle time of your program. In terms of SHARCNET clusters, you are looking to run your code on machines with dedicated, high-speed interconnects designed for this purpose (requin, bull, silky). If the code is of moderate granularity, it will not be as sensitive to the quality of the interconnect and you can obtain excellent performance on a cluster with a mid-range dedicated interconnect (narwhal, PoPs). A very coarse-grained parallel program will not be affected significantly by the network interconnect and now even the throughput cluster becomes an option (whale), which given its high processor count will make it easier for the scheduler to start your job.

The graph to the left, an interactive version of which also appears on the Facilities page of the web portal, illustrates a rough mapping of program granularity and job size to the major clusters available on which to run them.

Memory Bandwidth

The sustained rate at which data can be delivered to multiple processes simultaneously is the realm of memory bandwidth. A program that is hungry for data, relying on being able to access vast amounts of data in order to perform its job will not perform well on a machine with limited memory bandwidth. Fortunately, it is relatively easy to understand this issue in the context of architecture type and the manner in which a node is configured (information readily available from the web portal).

Given the hardware we have deployed, the Opteron-based clusters will provide the highest memory bandwidth due to the on-chip memory controller and hyper-transport channels allowing fast access to memory between processors in the same node. Core density further plays a role in understanding memory performance. Two single core processors per node, as exists on requin, minimize the pressure on memory allowing processors to achieve high throughput. Two dual core processors in a node, such as exist on narwhal, is slightly more constrained, although, as the memory controller is part of the chip, there are now two cores competing to access the single channel to memory.

If your program requires access to a continuous stream of vast amounts of data (memory bandwidth is typically expressed in GB/s to provide some perspective), you want to look at the machines constructed with high memory bandwidth in mind (requin, silky). For the record, most common parallel applications are not sensitive to memory bandwidth, and can be run productively on any cluster that suits its needs otherwise.

Understanding Queue Priorities

Another important consideration in selecting a cluster on which to run your job is the priorities afforded to the various queues, which have been set up deliberately to favour the sorts of jobs that should be run on the given hardware. The table below qualitatively summarizes the relative priorities of the mpi, threaded and serial queues on SHARCNET's major systems. While it is possible to run serial jobs on requin, you will note the very low priority assigned to that queue, making it more productive to us a cluster such as whale, which was designed with serial farming in mind.

This article has only touched on a few of the major issues that should be taken into consideration when picking a cluster on which to run your code. If you would like additional information, or assistance in understanding the characteristics of your application and/or selection of appropriate hardware on which to run your jobs, please contact one of SHARCNET's HPTC Consultants at your convenience.

Cluster	Queue	Priority
requin	**mpi** threaded serial	high moderate low
narwhal	**mpi** **threaded** serial	high high low
bull	**gaussian** mpi threaded serial	very high high high low
whale	mpi threaded **serial**	low moderate high
silky	mpi **threaded** serial	moderate high low
PoPs (dolphin, zebra, etc.)	**mpi** **threaded** serial	high high low

Shared Hierarchical Academic Research Computing Network

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