SHARCNET™

SHARC BYTES
newsletter

Ten Year Anniversary Edition 2011 VOL. 9 ISSUE 1

Seeing the Forest Beyond the Trees

UNIVERSITY OF GUELPH PROFESSOR USES ECOLOGICAL MODELLING TO STUDY FOREST DIVERSITY
BY KATHARINE TUERKE, STUDENTS PROMOTING AWARENESS OF RESEARCH KNOWLEDGE (SPARK) PROGRAM AT THE UNIVERSITY OF GUELPH

Photo of Wolf Lake, Ontario (M. Anand)

Forests make up 30 per cent of the Earth's surface, but they are shrinking at an alarming rate. Climate change, land use conversion, and invasion of foreign species are just some stresses forests are facing. Indeed, the decreasing number of forests and accompanying decline in biodiversity is a global concern, reflected by the UN's declaration of 2011 as the International Year of Forests.

Ecologists have a general understanding of biodiversity but the factors that create and maintain it are not well understood. Prof. Madhur Anand, School of Environmental Sciences at the University of Guelph, is developing computer models to study shifts in forest dynamics as a result of climate changes and various other human or natural disturbances.

"It's an attempt to understand how forests, a complex ecological system, work and are organized," says Anand.

Current models are limited. They use small geographic areas, time scales or examine only a few variables at a time, underestimating or ignoring the effect of others.

Anand says this approach isn't ideal for simulating such a diverse and dynamic system as forests.

To create more realistic and detailed simulations, the models developed in Anand's lab will use parallelization of individual-based models of forest dynamics to study global ecological change. With the help of SHARCNET's high-performance computing and adapted software, the models will be able to examine several spatial scales and parameters simultaneously.

Continued on page 6

10 YEARS SHARCNET™

in this issue:

Message from the Chair of the Board

I am pleased to present this ten-year anniversary edition of SHARC Bytes, which aims to highlight our successes over the past decade, and we hope will be a roadmap for the future.

SHARCNET's role in creating an HPC centre in Ontario can be traced back to a couple of researchers at The University of Western Ontario. Due to the lack of HPC resources available to them, Professors Allan MacIsaac and Peter Poole from the Department of Applied Mathematics at Western, partnered with Compaq Canada to write a grant proposal for supercomputing resources based at Western. The granting agency at the time liked the concept but responded "think bigger" and pushed the two to put forward a project application which would involve many more collaborators, institutions and researchers requiring HPC resources. This would ultimately lead to the official creation of SHARCNET.

Kevin Hall,
Chair of the Board

After ten years of steady expansion, SHARCNET has grown from seven partner institutions to 17, and is the largest HPC consortium in Canada by number of partners and range of support provided. In addition to its academic partners, SHARCNET's success would not have been possible without its government and industrial partnerships. Funding from CFI has allowed us to purchase a heterogeneous mix of infrastructure in order to meet diverse researcher needs. The province of Ontario has been a huge supporter of HPC by providing much needed operational funding allowing us to provide a rich and varied suite of research programs supporting HPC. Additional cash provided by our industrial partners, notably Hewlett Packard and Silicon Graphics, allowed us to run both the Chairs and Fellowships programs, which are the cornerstones of SHARCNET's mission to build and strengthen the HPC community. We plan to commemorate our ten-year anniversary at a SHARCNET event planned on December 3rd, hosted by the University of Guelph. We hope that many of you can join us in celebrating this important milestone with us!

In recent years, our focus has shifted to better align with the other HPC consortia as part of the national platform and move from regional to national HPC collaboration. SHARCNET has also been working steadily over the past couple of years with its provincial counterparts, SciNet and HPCVL, on an integration plan within the province. This will allow us to rationalize and streamline resources and is seen by the province as an improved model for securing additional funding. A couple of studies have been commissioned in recent months to consider the best model for structuring governance and management of HPC within the province, which should lead to a set of recommendations in the coming weeks.

As the landscape for HPC continues to shift, and SHARCNET evolves to keep apace with this change, we should never lose sight of our ultimate goal, which is to enable research. SHARCNET was created from the grass-roots efforts of many dedicated faculty and staff who sought to build an HPC organization to best serve the researcher community. It is therefore critical that the role of the research community continue to be as stakeholders and not simply relegated to the role of spectator.

I would also like to take this opportunity to thank the many faces of SHARCNET, from the Board level, to the Strategic Council, SHARCNET management and staff, and the researcher community at large for their tremendous support and contributions. All have played a role in the evolution of SHARCNET, and we hope will continue to do so as we move forward.

Kevin Hall
Chair, SHARCNET Board of Directors
Vice-President (Research)
University of Guelph

Scientific Director's Message

As we celebrate our ten-year anniversary, it gives me pause to reflect on what has been learned about building from scratch an organization like SHARCNET. It is certainly not easy and takes the efforts of many, both staff and volunteers. We have learned many lessons along the way, from how to set up a governance and management structure, to how to build an effective organization and staff it with the right people, and above all, how to best serve the needs of the research community in a way that appears seamless, is user friendly and enables outstanding research. It took a few mistakes and several years of hard work to truly hit our stride - and as a service organization we can always improve - but after five years, and several successful grant applications for infrastructure and operational funding, SHARCNET had emerged as a highly regarded, world-class HPC centre for research.

But as Bob Dylan wrote, "the times they are a changing." Several years ago the pressure began building to rationalize and evolve HPC services in Ontario by better aligning the three provincial consortia. The goal is a sustained, world-class, computational infrastructure in Ontario that will lead in Canada and rank alongside the best in the world. The vision and interest of the province in creating and supporting a resource to enable HPC across the spectrum of academia and industry is a huge opportunity for our community. As a result, the three Ontario consortia are positioning themselves to create a new entity which will govern and manage the HPC resources for all of Ontario. Looking ahead, what this means for SHARCNET remains unclear, but there is no doubt that there will be evolution. The trick will be to harness the strengths of the three individual consortia to create a second-to-none computational resource.

While the details of provincial alignment are being fleshed out, SHARCNET, as part of Compute Canada, has submitted a grant application to CFI's Major Science Initiatives program. If successful, this grant will provide a much needed injection of operating funds to support Compute Canada and its consortia, or regional divisions, providing much needed stability over the next five years. The major challenge for us continues to be our aging infrastructure. Given that our last major refresh led to equipment on the floor close to 6 years ago, most of our systems are now reaching end of life. Worryingly, this is just the tip of a poorly perceived iceberg that threatens the entire National Platform in the coming 3-4 years. We will continue to try to maintain our systems for as long as we can, although some will most certainly be decommissioned. On the positive side, we are currently installing the last piece of equipment from the National Platforms Fund, which will provide a modestly increased GP-GPU capability. This new cluster will contain more than 100 Nvidia m2070 GPUs and we hope to have the new system up and running early in the new year.

As usual, SHARCNET staff have been very busy over the last several months on a number of fronts, including user support, training, HPC outreach and supporting specific Compute Canada initiatives. I want to take this opportunity to thank them for all of their hard work and dedication, especially as we reflect on the past decade and how far we have come. Hardware will come and go, but it is the contributions of the staff who support the organization that truly are the key ingredients for success.

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

Hugh Couchman,
Scientific Director

"The three Ontario consortia are positioning themselves to create a new entity which will govern and manage the HPC resources for all of Ontario."

-Hugh Couchman

What Fires Together, Wires Together

UNIVERSITY OF WATERLOO THEORETICAL NEUROSCIENTISTS BRIDGING THE GAP BETWEEN NEUROBIOLOGY AND COMPUTER MODELLING
BY KATHARINE TUERKE, STUDENTS PROMOTING AWARENESS OF RESEARCH KNOWLEDGE (SPARK) PROGRAM AT THE UNIVERSITY OF GUELPH

Chris Eliasmith
University of Waterloo

The power of modern computers grows, as does our understanding of the human brain... but can a computer ever model the brain? Traditionally there are two approaches to modelling the brain – one that simulates human thought, and the other that models its low-level network structure. Recently, these two approaches have been unified by a new method called the Neural Engineering Framework (NEF).

Chris Eliasmith is a professor in the Department of Systems Design Engineering and in the Department of Philosophy at the University of Waterloo. His NEF method is implemented in a software environment called Nengo (an amalgam of neural engineering objects). It simulates how neurons and neural systems interact to represent information, perform computations, and behave in perceptual, motor, and cognitive tasks.

"Nengo is a tool that can be used to model high-level cognition such as problem solving and learning using biologically realistic neurons," says Eliasmith.

The human brain consists of a network of several billion nerve cells called neurons. These neurons are connected to one another by synapses. Every time we think, move, see or remember something, a small electrical signal fires from neuron to neuron (an action potential) that is generated by differences in electric potential and moving ions in the cell membrane.

Nengo mimics this activity in detailed models of single cells. The basic computational element (a model neuron) can receive or send inputs to other elements. Much like the neurons in the brain, these model neurons send or receive inputs to each other using action potentials, which capture the change in voltage in individual cells, sending signals to one another.

Every time we learn something, the structure of our brain changes. Information travels along a network of synaptic connections, with more activity creating stronger synaptic connections. This phenomenon is called synaptic learning – and Nengo can do it too.

Each input in the model has an associated weight, which can change to model synaptic learning. The weighted sum of inputs is called a net input and its output signal can become an input for other neurons. This signal transmission in Nengo models represents synaptic communication between neurons and brain structures in humans.

Nengo has been used to simulate more than one million neurons, and requires extensive parallel processing to simulate synaptic communication and learning. SHARCNET provides the hardware resources required for the large amounts of data and calculations produced by the millions of model neurons. SHARCNET's number of large and powerful computers speed up the data collection by increasing the number of simulations run, as well as allowing more complex models with greater neurobiological details to be tested.

"The approach is versatile; it can be used to simulate simple tasks like a lamprey moving or be scaled up to more abstract and complex tasks such as taking a general intelligence test," says Eliasmith.

Nengo has been used to simulate motor control for arm movements as well as high-level cognitive tasks. It can model various learning and memory effects including, one trial learning, object recognition, and working memory. Nengo has also been used to build a brain model that solves the complex logic puzzle, the Tower of Hanoi, a task that requires planning and goal-directed action.

Other work by doctoral student Daniel Rasmussen has shown that Nengo can also solve Raven's Progressive Matrices, a measure of general intelligence. The purpose of the test is to identify the missing element that completes a pattern which is presented in the form of a matrix. Previous models used precoded rules to solve the problem, whereas Rasmussen's model learns to solve the problem on its own by comparing features of the symbols.

Performance on the Raven's Matrices declines in humans as they age as result of neuron loss and decreased processing ability. To investigate if the Nengo model can replicate this age effect, model neurons were removed, but the input remained the same. A population of Nengo models showed a performance declined on the task, mirroring the population data collected on humans. That means Nengo, can simulate high-level cognitive tasks as well as age-related changes in human performance.

The Nengo software and the underlying NEF methods have the ability to reproduce human cognitive performance effects found by neuroscientists and psychologists. Unlike traditional approaches, Eliasmith's combines high-level cognitive behaviour with realistic neurobiological simulations. Future studies will investigate performance on other cognitive tasks as well as try to further increase the realism and number of neurons simulated at the biological level.

Funding for this research is supported by SHARCNET, the Natural Sciences and Engineering Research Council, the Canada Foundation for Innovation, the Ontario Innovation Trust and the Canada Research Chairs program.

Connect. Compute. Collaborate.

HPCS 2012 • May 1-3, 2012

This spring, WestGrid and Compute Canada will be hosting HPCS 2012 as a joint conference with BCNET. On May 1-3, 2012, the conference, themed **Connect. Compute. Collaborate**, will focus on advancing higher education and research by promoting innovative and smart ways to use and share information technology.

Compute Canada will bring together Canada's HPC community in Vancouver for their annual High Performance Computing Symposium (HPCS). HPCS is a multidisciplinary conference that focuses on research involving High Performance Computing and its application.

Attended by Canadian and international experts and renowned researchers in the sciences, all areas of engineering, the applied sciences, medicine and life sciences, mathematics, the humanities and social sciences, it is Canada's pre-eminent forum for HPC. The three-day conference will be held at Simon Fraser University Harbour Centre in Vancouver, B.C. More details to follow soon.

compute • calcul CANADA

WestGrid

BCNET The Backbone of Research, Education and Innovation

Seeing the Forest... continued from page 1

The models will also be able to examine several ecological organizational scales, from individual trees to populations and the ecosystem at large. The highly-parallelized model will be capable of handling more than 300,000 individual trees, with real life cycles, hundreds of species, and multiple hectare plots. The versatile model can be used to study both the climate sensitive temperate forests as well as the species rich tropical forests.

"The power of a well-designed, versatile model with great computational ability will be an invaluable tool for hypothesis testing in the ecological research community and will complement other approaches being developed around the world," says Anand.

Anand and her team will investigate scenarios of stress and disturbance using field, historical, and published data as well as data from international databases. For example, she will use data collected from their own Ontario sites to parameterize decreasing growth rates due to limited resources. Additionally, she will use data collected from the Wolf Lake Conservation Reserve and Haliburton to examine how hypothetical disturbance patterns can alter recovery dynamics and migrations patterns in northern forests. Finally, using her restoration and recovery data from the Sudbury region, she hopes to parameterize a model that simulates changes in the range of native and non-native (including invasive) species, under different restoration regimes and climate change.

"To create more realistic and detailed simulations, the models developed in Anand's lab will use parallelization of individual-based models of forest dynamics to study global ecological change."

These models will be used to study how forests might respond to both human and natural disturbances as well as climatic changes. The recent invasion of the Asian Long Horn Beetle is an example of a natural disturbance whereas deforestation and changes in land use are considered human disturbances. Changes in temperature and precipitation affect forest location, composition, and productivity are also of interest.

"We need to rethink the impacts of climate change. We need to consider multiple stressors and interactions with disturbances. More research is needed in these areas to better predict implications for forest productivity, management and even restoration," says Anand.

A greater understanding of the complex interaction of forest dynamics will provide insight into the mechanism underlying forest diversity and help to develop successful conservation programs to deal with the global forest scarcity problem. These projects will help strengthen existing collaborations with other researchers as well as bring new modellers to the SHARCNET community.

This work was supported by Anand's NSERC Discovery Grant and by SHARCNET's Dedicated Programming Resource grant. The work is conducted with collaborators at the University of Guelph, University of Western Ontario, CSIRO (Australia) and Universidade Federal Rio Grande do Sul (Brazil). A recently awarded NSERC CREATE grant in "Modelling Forest Complexity" led by researchers at UQAM (Montreal) in which Anand is a co-applicant, will ensure that the approaches being used and information being generated will be shared with the emerging researchers and trainees in this area across Canada and internationally.

Research Day

"HPC Innovation for Research"

Sheridan College • May 19, 2011

SHARCNET Research Day 2011

BY RALF MEYER, LAURENTIAN UNIVERSITY

In May, the SHARCNET user community gathered at Sheridan College in Oakville for SHARCNET Research Day 2011. Research Day is an annual event that allows the users of SHARCNET to come together for one day to showcase their research results, discuss high-performance computing and to get to know each other.

As in the previous years, the scientific program of SHARCNET Research Day 2011 consisted of two invited keynote lectures, contributed talks and a poster session. In addition to this, a townhall meeting chaired by SHARCNET's scientific director Hugh Couchman provided a forum to discuss the future of high-performance computing in Canada and Ontario.

The first highlight of the day was the keynote lecture on *"Computer (and Human) Perfection at Checkers"* by Dr. Jonathan Schaeffer. Dr. Schaeffer is currently Vice Provost and Associate Vice President (Information Technology) at the University of Alberta. He is well known for his work on computer checkers which lead to the game being solved in 2007. In his talk, Dr. Schaeffer gave an animated account of the high-performance computing aspects of his quest to develop a checkers playing computer program able to defeat a human world champion.

The second keynote lecture brought the audience from the tiny world of the checkers board to the final frontier: space. Astrophysicist Dr. Ralph Pudritz who is Professor at McMaster University and Director of the Origins Institute gave a presentation entitled *"Computing the Origin of Stars and Stellar Masses"*. In his lecture, Dr. Pudritz used spectacular visualizations to show how he uses SHARCNET's high-performance computers to uncover the secrets of star formation.

The keynote lectures were complemented by 14 posters and 26 oral presentations from SHARCNET users. These contributed presentations are an important part of SHARCNET's Research Day. They make it possible for SHARCNET users to connect with each other, to learn about each others research subjects and to see how other groups make use of SHARCNET's facilities. The wide range of subjects covered by the contributed talks gave an impressive display of the variety of the SHARCNET user community.

As a member of the organizing committee for SHARCNET Research Day 2011 I would like to thank all the people that have helped to make SHARCNET Research Day 2011 a success. I first thank all the presenters for their contributions. My next thank you goes to the SHARCNET site leaders and the SHARCNET staff for their support. Finally I would like to thank the people from Sheridan College for providing us with a very warm and welcoming environment.

Summer School 2011

BY DAVID MCCAUGHAN, HPTC CONSULTANT, SHARCNET

Participants of Ontario HPC Summer School 2011, Sheridan Institute, Trafalgar Campus, Oakville, Ontario, June 2, 2011.

At one point, Pink Floyd had a generation chanting, "we don't need no education". It seems they weren't talking about Ontario's High Performance Computing community as we look back at another successful summer school event. Times change though, and what was previously something SHARCNET offered over a week during the summer had to evolve. As the various consortia mature there is a natural evolution toward cooperation in training opportunities and the Summer School was one of the earliest opportunities we had to put this into practice.

2011 marked the first year of what we called the "Ontario Summer School on High Performance Computing", explicitly intending to service the user community at all three Ontario consortia. The event was held at the Sheridan Institute of Technology and Advanced Learning (Oakville campus) from May 30 to June 3, 2011. While the format would be familiar to those who may have attended in previous years, this year's event was notable by being organized and run jointly by representatives from HPCVL, SciNet and SHARCNET: the three consortia representing the province's academic and research communities. Our appreciation goes out to Jonathan Dursi (SciNet), Hartmet Schmider (HPCVL) and Gang Liu (HPCVL) for their assistance in both planning and delivery of a very well received Summer School event for the Ontario academic community.

As always, we attempt to run unofficial social events in the evenings to allow for a better exchange of information and ideas between attendees and organizers. This would typically involve dinner and/or drinks at nearby establishments. These things are always enjoyable for those who make time for them.

The format of the summer school has firmed up considerably over the years it has been offered. Attendees have made it increasingly clear to us that the summer school should be viewed as a recurring venue focused on more in-depth education for users new to the community. As a result, this year saw a five-day slate of courses spanning two streams, covering a variety of topics including HPC fundamentals, MPI and OpenMP programming, best practices in HPC software design, debugging and a variety of special-interest topics such as GPU programming and MATLAB, which closely matches the more popular courses that have been offered in recent years.

As we peer into the crystal ball and attempt to see where things are going in the future, I think it is fair to take note of a few lessons we learned this year. First, it is unlikely that a single event such as this can adequately service the entire Ontario academic community. While it may be possible to accommodate it from an administrative point of view, it simply isn't possible to hold the event in a location that will not be a barrier to attendance from some sites (regardless of travel subsidy availability). Second, we are increasingly seeing poor attendance at the less introductory sessions which is leading us to consider that the event should simply be entirely focused on the users new to the HPC community, in which case we would consider removing the two streams of courses and sacrifice our attempt at greater breadth for a more focused coverage of a standard introductory curriculum.

Planning for the 2012 joint Summer School cycle is already underway and will likely see an expansion of offerings to better serve the geographically diverse community within the consortia, with an accompanied reduction in duration to four days rather than five to respect the tighter focus on material.

The History of SHARCNET

Prior to the first SHARCNET project, the lack of competitive high performance computing programs and services was seen by a critical mass of researchers as a failure in Canada. Thus, a move and decision was made by a group of researchers to address this through a joint grant application, involving a number of institutions in Southwestern Ontario. This led to the creation of SHARCNET. In the face of rapid hardware obsolescence for HPC hardware, SHARCNET's key objective was to build an "HPC culture" in Ontario and Canada: a community of skilled researchers which would support the growing demands in academia and the private sector for HPC and would generate the critical mass of users to ensure long-term support and provision of leading hardware resources. SHARCNET aimed to directly target researchers with large problems which could not otherwise be contemplated.

Formally established in 2001, SHARCNET is the culmination of the vision of several faculty from McMaster University, The University of Western Ontario, and the University of Guelph. These individuals developed the successful grant applications to the Canadian Foundation for Innovation (CFI), Ontario Innovation Trust (OIT) and the Ontario Research and Development Challenge Fund (ORDCF) to create SHARCNET. These funds resulted in the installation of massively parallel computing systems across the SHARCNET institutions, as well as the research programs (Chairs and Fellowships), which were the first among other HPC centres in Canada. Further grant applications to CFI and OIT, awarded in 2004, allowed SHARCNET to significantly upgrade and expand its infrastructure.

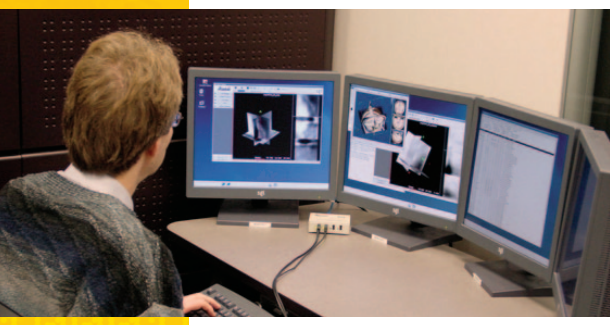
SHARCNET was originally founded with seven institutions: McMaster University, The University of Western Ontario, University of Guelph, University of Windsor, Wilfrid Laurier University, Fanshawe College and Sheridan College. The SHARCNET partnership was expanded in June 2003 to include the University of Waterloo, Brock University, York University and the University of Ontario Institute of Technology. In December 2005, SHARCNET expanded the partnership again, with the addition of Trent University, Laurentian University and Lakehead University. In March 2006, Perimeter Institute and OCAD University were added to the consortium. In 2008, Nipissing University joined SHARCNET for a total of 17 academic partners, making it the largest HPC consortium working under the national coordinating body of Compute Canada.

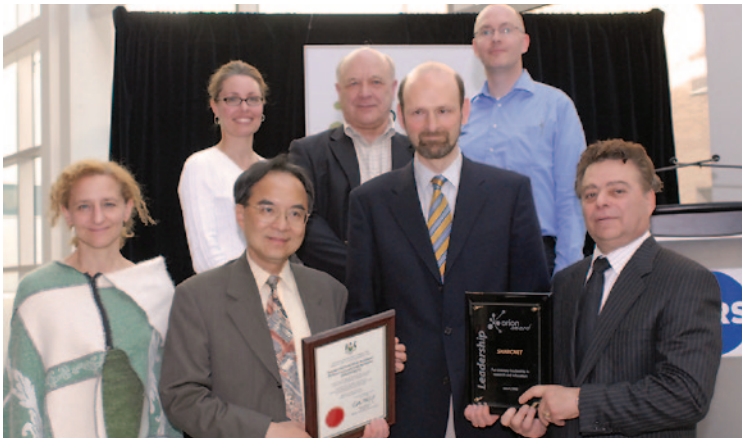
In addition to its academic partners, SHARCNET's continued success wouldn't be possible without its government and industrial partnerships.

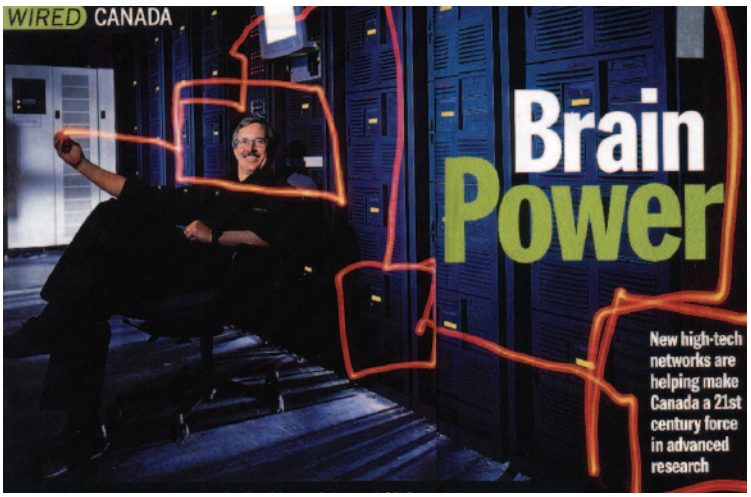
SHARCNET statistics:

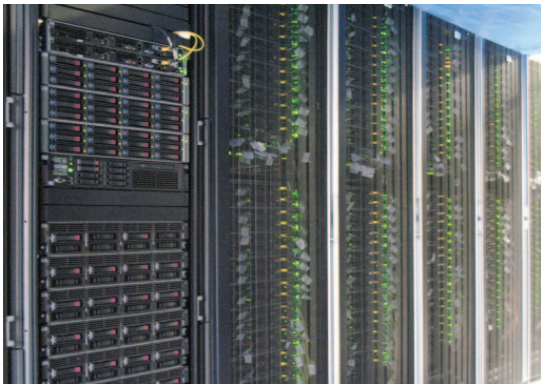
- 1,000 research groups
- 4,000 total users
- 100 institutions
- 150 research areas supported
- 60 industrial research projects
- 2,000 publications
- 19 SHARCNET Research Chairs recruited
- 203 SHARCNET Fellowships awarded

A Trip Down Memory Lane






WIRED CANADA
Brain Power
New high-tech networks are helping make Canada a 21st century force in advanced research

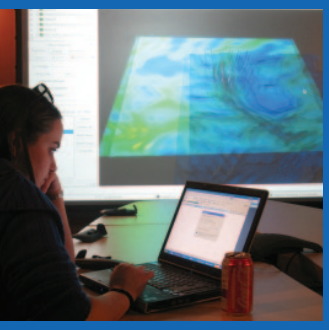



fedora


The stellar mass spectrum (IMF) 50 years after Salpeter (1955): (eg. Chabrier 2005)
Salpeter power law above 1 M☉
Lognormal below this mass down to 10 Jupiter masses
Characteristic mass ~0.2 M☉
Universality: disk, spheroid, young and old globular clusters


• 2011 Survey open n
– win an iPo Touch!


Parallel Optimization Approaches for Medical Image Registration
robarts



"Each person should only access SHARCNET or Compute Canada resources with their own account and should strive to keep their credentials private."

SHARCNET security is everyone's responsibility. As exemplified by the security compromises on Compute Canada systems this past summer, even systems running relatively secure operating systems like GNU/Linux are prone to being compromised by an unauthorized intruder. Unfortunately once systems are compromised we must take them offline to investigate and re-install software on the system, and there is always the danger that something malicious or illegal may have occurred. SHARCNET takes these security intrusions very seriously and we strive to ensure our shared resources are secure. Part of this effort includes informing account holders of good security practices and helping them keep their account authentication credentials secure.

The primary method used to access UNIX-based systems remotely is via SSH. When logging in via SSH one must typically authenticate with a password when prompted, or automatically with SSH keys. While the SSH software itself is very secure, the security of the entire system depends on all users keeping their access credentials safe and private. At the outset an intruder only needs to acquire regular user access to a system, it doesn't matter whose account they use. Once an intruder has access to a regular user account it may be possible for them to obtain privileged administrator access by exploiting a vulnerability in the software installed on the system. With administrator privileges an intruder is free to modify the system as they wish and as such the system is considered compromised.

One of the primary activities that an intruder undertakes once they've compromised a system is harvesting credentials so that they can break into new systems. For example, they can copy the system's encrypted password file, which may contain user account passwords, and then proceed to crack the passwords in it. Another common intruder activity is installing key-logging software that stealthily gathers passwords as users log in. By gathering credentials and watching which systems users access the intruder can easily find and attack new targets. With these concerns in mind we will focus on strategies to ensure your SSH credentials are secure.

First and foremost, never share your credentials with other people. In fact, everyone actually acknowledges that they will not do so when they accept the SHARCNET and Compute Canada Acceptable

Use Policies. This includes "lending" your account to other people in your group, or leaving your password written down somewhere where others can easily read it (eg. on a post-it note on the side of your monitor). Each person should only access SHARCNET or Compute Canada resources with their own account and should strive to keep their credentials private. Ultimately you are responsible for any activity associated with your accounts.

Going a step further, it is strongly recommended that you do not write down your passwords or passphrases at all, these should be memorized. This especially includes storing one's password in clear-text (eg. in an email or text file) on any computer, as an intruder would be able to find it with little effort.

It is also recommended that users create a new password for each account they have, rather than a single generic password for all accounts. This will limit the reach of an attacker should they obtain one of your passwords. If you are worried that you cannot remember all of your passwords there are programs that will allow you to encrypt them and retrieve them from a "locker". Using such a tool may be worthwhile but it is not as effective at maintaining security as memorization.

The recommendation to memorize multiple passwords may incline one to pick "simple" passwords or SSH key passphrases that can be recalled easily, but it is actually very important that one not choose a simple password. Simple passwords can be guessed by an attacker via brute-force methods (e.g. trying to log in to your account by repeatedly trying different dictionary words and names) and they are also much easier to decode from an encrypted password file. To avoid a simple, or cryptographically weak password, one should ensure that their password is not based on a dictionary word or a proper name, is long (at least 8 characters – the longer the better), and to a lesser extent that it contains symbols, numbers, and letters of both cases.

The easiest approach to crafting a memorable and strong password is to creatively concatenate a long phrase, using substitution of symbols/numbers/case for further strengthening. This will allow you to recall it from memory much easier than a random string of characters, and will still be very difficult for an intruder to decrypt or guess. For further information you can find detailed instructions on this password generation method in our help wiki "Choosing a Password" at https://www.sharcnet.ca/help/index.php/Choosing_A_Password .

While these efforts will protect your account from attacks that guess your password, one will still be prone to having their password harvested by a key-logging program on a compromised system. One way to avoid this is to authenticate using an SSH key instead of logging in via password. An SSH key is actually a private and public key pair. One keeps the private key on their local system and unlocks it locally by entering the passphrase. This is registered by an SSH agent program that stays running for the duration of your local login session, and whenever you SSH to a remote system the agent will forward a challenge to the remote system. It is then compared with your remote public keys and if there is a match you are granted access to the system. As such you don't actually type in any passwords on remote systems and are safe from having your password logged. This authentication method has the added convenience that you don't need to type in your password every time you log into a new system!

While keys may seem like a net security win, one must be careful with them as well. There is no reason to leave your private key anywhere else than on your local computer or on a storage device that you keep with you (e.g. USB flash drive). If it is left on remote systems, an intruder could find it and crack your passphrase. Along these lines, it is extremely dangerous to use an SSH key without a passphrase, as anyone who obtains your private key will be able to use it to log into any system where you have stored your public key, with absolutely no effort. For further details on setting up and using SSH keys please see the aforementioned "Choosing a Password" help wiki page.

In summary, it is worth reiterating that we are all sharing common resources. No one enjoys having their work disrupted, especially when it is a result of something that can be avoided. We must all do our part to minimize the opportunity for intruders to compromise our systems, and the first line of defense is maintaining secure account authentication credentials.

2001: An HPC Odyssey

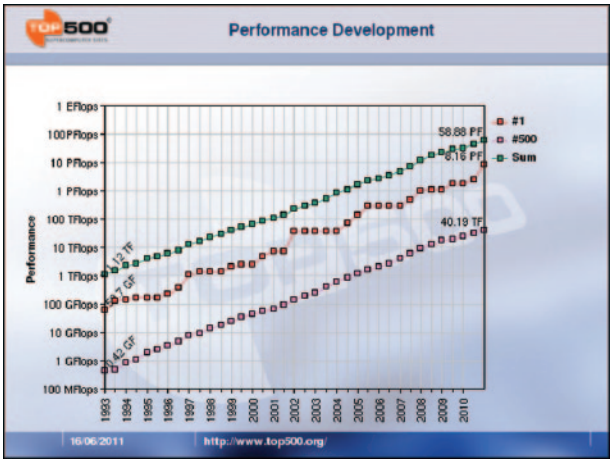
BY JOHN MORTON, TECHNICAL MANAGER, SHARCNET

This journey begins not with apes but with alphas - Compaq alphas to be exact. SHARCNET was formed by the seven founding institutions and three primary systems were deployed to help support the computational requirements of our research community. These systems were deployed at McMaster University, University of Guelph and the University of Western Ontario. Combined these systems provided ~1 TFlops while at the time each of the top systems in the world were approaching 10 TFlops.

In 2002 Japan deployed a new system providing more than five times the computing power of the next largest system in the world. It was named the Earth Simulator and it would hold the top spot for 5 editions of the top 500 list. It was composed of over 5,000 processors and was measured at 35 TFlops.

From here the systems continue to grow at exponential rates. In order to simply get on the top 500 list in 2005 a system had to top 1 TFlop in measured performance.

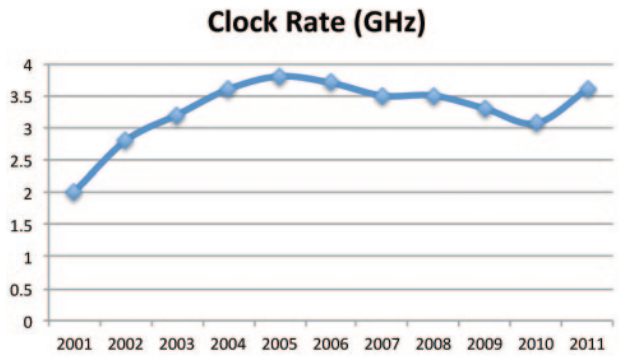
From our modest beginning, SHARCNET's computational capabilities were greatly expanded in 2006. Over the course of this year SHARCNET deployed five major systems with the highest ranked system being whale at position 80 on the top 500. Whale was measured at over 13 Tflops which on its own nearly doubled SHARCNET's computing power.



Over the next few years the industry continued to make improvements in all areas of HPC. Networks became faster and node level performance continued to increase. These improvements and the inclusion of dedicated accelerator cards led to the 1 PFlop barrier being broken in 2008. Today each of the 10 top systems are all over 1 PFlop with three of them utilizing an accelerator card.

Over these past 10 years we've seen major advances in the capabilities in nearly all system and network components. CPUs have gone from single core processors in 2001 to today's many core chips. Memory has become faster and available in much higher densities. The networks connecting the individual nodes have much lower latencies and much higher bandwidth. The one important component that has not seen much improvement has been the individual clock speed. While the individual cores have had wider computational paths and better access to memory the improvements in clock speed have not increased at the same pace and in fact have only seen very modest gains.

What will the next 10 years hold? GPUs and other accelerators will continue to play an important role in overall performance. Power has been a concern for a few years and will continue to be a major consideration in the design of systems. The industry is moving towards exascale computing with the expectation of the first system of that size coming online within 10 years. If this system is achieved, we will have gone from 10 teraflops to 1 exaflop under 20 years.



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"Thank you to all the SHARCNET staff for all of their hard work and dedication, especially as we reflect on the past decade and how far we have come. Hardware will come and go, but it is the contributions of the staff who support the organization that truly are the key ingredients for success."

-Hugh Couchman

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