6th Symposium of the Los Alamos Computer Science Institute: LACSI 2005 ♦ 11 - 13 October
LACSI 2005 Chair: Dr. Rod Oldehoeft (rro@lanl.gov); **Program Chair**: Dr. Rob Fowler (rjf@rice.edu)
Symposium Site: Eldorado Hotel, 309 West San Francisco Street, Santa Fe, NM 87501

WORKSHOPS & TUTORIALS (11 OCT., TUESDAY)

LOCATION: Eldorado OR the Hilton (across the street); room assignments will be available at Check-in.

(1) High Availability & Performance Computing **(full day)**
    Contact person: Leangsuksun, Chokchai Box, Louisiana Tech University (box@latech.edu)
    Organizers: Chokchai Box Leangsuksun, Louisiana Tech U; Stephen Scott, ORNL

High availability and performance computing has recently become a recognized important combination to those organizations that require tremendous computing power to solve their important problems such as Energy, Climate, Fusion, Biology, and Nanotechnology. These non-trivial problems are usually characterized by massive and long running applications; therefore, Reliability, Availability, and Serviceability (RAS) management will become an increasingly paramount aspect in many computing environments. RAS management goals are to maximize uptime and therefore undoubtedly complement High End Computing (HEC) objectives by preventing performance degradation and spectrum availability. High Availability (HA) Computing has always played a critical role in commercial mission critical applications. Likewise, High Performance Computing (HPC) has equally been a significant enabler of the R&D community because of their scientific discoveries. Serviceability aims toward effective means by which corrective and preventive maintenance can be performed on a system. Higher serviceability improves availability and helps retain quality, performance, and continuity of services at expected levels. The combination of HA, Serviceability, and HPC will clearly lead to even more benefits to critical shared major HEC resource environments. This third annual workshop (HAPCW2005) is a forum for the discussion of topics related to the issues affecting HAPC.

(2) Advanced Numerical Methods for PDEs **(full day)**
    Contact person: Boyarkin, Oleg, University of Houston (boyarkin@math.uh.edu)

Participants in WS2 will discuss new developments and challenges in construction, investigation, and applications of new numerical methods and algorithms for the solution of partial differential equations relevant to LANL applications. New discretization methods for PDEs on arbitrary polyhedral meshes, their stability and accuracy, and efficient preconditioned solvers for underlying large-scale algebraic systems as well as interface reconstruction algorithms are among the major topics of the workshop.

(3) Performance & Productivity of Extreme-Scale Parallel Systems   **(full day)**
Contact person: Hoisie, Adolfy, LANL (hoisie@lanl.gov)
Organizers: Adolfy Hoisie, PAL/LANL; Dan Reed, UNC/Institute for Renaissance Computing

In WS3 we will be concerned with the interplay across system architecture, network, applications, and system software design. The invited speakers, leaders in these fields, will cover these areas and also address the state-of-the-art in methodologies for performance analysis and optimization including benchmarking, modeling, tools development, tuning and steering, as well as metrics for productivity. We envision WS3 to be composed of 4 sessions of 3 talks each.

(4) Models & Simulations for Large-Scale Socio-Technical Systems   **(full day)**
Contact person: Eidenbenz, Stephan J, LANL (eidenben@lanl.gov)
Organizers: James P Smith, LANL; Stephan Eidenbenz, LANL; Gabriel Istrate, LANL; Anders Hansson, LANL; Christian Reidys, LANL

Complex socio-technical systems consist of millions of interacting physical, technological, and human/societal components. Examples of such systems include transportation systems, national commodity markets, telecommunication and computing systems including the Internet, and public healthcare systems. High-fidelity simulations capable of representing and analyzing such complex systems require the use of high performance computing platforms and tools. WS4 aims to bring together some of the leading researchers with the goal of identifying fundamental issues in designing, implementing, and using such simulations on high-performance computing architectures. Topics include the following: scalable HPC oriented design of such simulations; distributed algorithms and their implementations; and large-scale discrete event simulation systems.

(5) High Performance Computing in Beam Physics & Astrophysics   **(full day)**
Contact person: Habib, Salman, LANL (habib@lanl.gov)
Organizers: Salman Habib, LANL; Robert Ryne, LBNL

Particle-based codes are among the most widely used high performance computing tools today, essential components of the state-of-the-art in fields, such as astrophysics and cosmology, compressible and incompressible fluid dynamics, and plasma and beam physics. Several large-scale applications are now at a threshold where they can be used as precision tools rather than as quantitative indicators of system behavior. Certain target problems in beam physics and astrophysics and cosmology have very stringent error control requirements for next-generation simulation frameworks and tools ranging from sub-percent to parts per million. Additionally, the success of major projects (e.g., the International Linear Collider) and large-scale cosmological surveys (e.g., the Joint Dark Energy Mission, Dark Energy Survey, and Large Synoptic Survey Telescope) depends on accurate and truly predictive simulations. That these projects represent a multi-billion dollar science investment further underscores the importance of high-performance simulation tools to their success. In WS5 we will aim to bring together researchers in these fields to discuss the future challenges in high-performance simulations for beam physics and astrophysics. WS5 will enable researchers to share successful strategies that have worked in their subdisciplines and to outline the areas where more work is clearly needed. A joint strategy for attacking these problems will be a major aim of WS5.

(6) Automatic Tuning of Whole Applications   **(full day)**

Contact person: Kennedy, Ken, Rice University (ken@rice.edu)
Organizer: Ken Kennedy, Rice University

For many years, retargeting of applications for new architectures has been a major headache for high performance computation, requiring many person-months (or even years) of effort to retune each new architecture, and even each new model of an established architecture. Automation of this retuning process has now become a fertile area of computer science research. Most of this work is based on the strategy of using large amounts of computation time to explore a space of different variants of a loop nest, running each variant on the target architecture, and picking the best one. One example of this strategy is the Atlas system, which uses substantive amounts of computation to provide versions of a computational linear algebra kernel that are tuned in advance to different machines. If this approach can be extended more generally to components and whole programs, it would help avoid the enormous human costs involved in retargeting applications to different machines. A major research issue is how to bring the tuning time to manageable levels, given that the number of variants in a complete application can be enormous. WS6 will report on the ongoing research efforts in this area, solicit feedback from and collaboration with the application development community, and exchange ideas on the future directions for this work. One specific subgoal will be to initiate an activity to develop a standard set of benchmarks for use in automatic tuning research.

(7) Algorithm Acceleration with Reconfigurable Hardware   **(full day)**

Organizer and contact person: Maya Gokhale (maya@lanl.gov; 505-665-9095)

Over the past 15 years, direct execution of algorithms in reconfigurable hardware has demonstrated speedup of 1 to 2 orders of magnitude over equivalent software. Reconfigurable Computers (RC) using Field Programmable Gate Arrays (FPGA) as processors have emerged as co-processors to augment microprocessors in workstations, clusters, and supercomputers. While RC offers remarkable opportunities for performance, research challenges abound:

- designing system architectures that balance conventional and reconfigurable processors
- developing analysis and compiler tools to automatically map
- algorithm kernels to hardware
- minimizing communications costs between hardware and software
- designing highly parallel, fine-grained computational elements for direct hardware execution
- scheduling and managing reconfigurable computing elements in large systems

The purpose of WS7 is to discuss successes and challenges of reconfigurable supercomputing. The AM session will present introductory topics and applications; the PM session will include research topics in FPGA-based architectures, systems, tools, and future directions.

(8) Parallel Programming with Charm++ and AMPI (full day)
Contact person: Mendes, Celso L., University of Illinois (cmendes@cs.uiuc.edu)
Organizers: Laxmikant V. Kale, University of Illinois; Celso L. Mendes, Univ. of Illinois

Adaptive MPI (AMPI), Charm++ and the frameworks built upon them have emerged as powerful parallel programming systems in recent years. By allowing programmers to divide the computation into a large number of entities that are mapped to the available processors by an intelligent runtime system, Charm++ enables a separation of concerns between the programmers and the computing system. This approach leads to both improved programmer productivity and higher system performance. WS8 will focus on showcasing leading research in parallel processing based on Charm++ and its frameworks. Topics will include tutorial-level introduction to Charm++ and AMPI, followed by case studies of applications developed using the frameworks, as well as advances in AMPI/Charm++ technology itself. Authors and attendees will be encouraged to share their experiences and plans for the systems built upon Charm++/AMPI.

(9) LinuxBIOS Summit (full day)
Contact person: Minnich, Ron, LANL (rminnich@lanl.gov)

WS9 will include a structured set of talks and a less structured discussion period. We will explore the current status of LinuxBIOS, including presentations by vendors on how they are using or plan to use LinuxBIOS in their products. We will discuss successes as well as problems and draw lessons learned from both. We will try to determine where LinuxBIOS should be taken next and to set goals and figure out how to meet them. We plan to close by producing a consensus document on the next steps needed over the coming year.

(10) Application Development Using Eclipse & Parallel Tools Platform (full day)
Contact person: Watson, Gregory, LANL (gwatson@lanl.gov; 505-665-0726)

Eclipse is an extensible, open-source integrated development environment (IDE) meant to be a full-featured, commercial-quality platform for development of highly integrated software tools. Eclipse offers many features: syntax-highlighting editor, incremental code compilation, thread-aware debugger, code and class navigator, file/ project manager, interfaces to standard source control systems, and support for Java, C, C++, Fortran, and other languages. The Parallel Tools Platform (PTP) is an official Eclipse Foundation Technology Project that focuses on integrating parallel tools into the Eclipse environment for enhanced application development. PTP supports a range of architectures and runtime systems and simplifies interaction with parallel systems. WS10 will introduce Eclipse and PTP, provide hands-on experience at managing and developing software, demonstrate both C/C++ and Fortran Development Toolkits, and present PTP tools. Participants will be able to use their own laptops (Linux or OS X) with supplied Eclipse and PTP software to maximize the hands-on time at software development activities.