Abstract

This workshop provides a forum for an overview, project presentations, and discussion of the research fostered and funded initially by the NSF Next Generation Software (NGS) Program, and more recently through the Advanced Execution Systems (AES) and the Systems Modeling and Analysis (SMA) components of the follow-up Computer Systems Research (CSR) Program. The present workshop is part of the series of the Next Generation Software Workshops that have been conducted since 2001, on a yearly basis and in conjunction with IPDPS. The topics addressed in the workshop are on research in systems’ software technology in the scope of NGS and of the AES and the SMA components, namely: methods for systems modeling and analysis, performance engineering, dependability, fault tolerance, and power-management, programming environments, enhanced compiler capabilities, tools for the development, dynamic runtime support and dynamic composition of complex applications executing on heterogeneous, parallel and distributed computing platform assemblies, such as computational grids, encompassing, advanced multiprocessors nodes, mid-range and high-end platforms, clusters, embedded and sensor systems, and special purpose processing systems.

1 Introduction

Research on novel directions in systems software in the areas of computing systems performance engineering methods and dynamic runtime environments has been fostered through the Next Generation Software (NGS) Program (1998-2004), and subsequently through the Advanced Execution Systems (AES) and the Systems Modeling and Analysis (SMA) components of the successor program, the Computer Systems Research (CSR) Program (2004-todate). The majority of the projects supported within the scope of NGS, AES and SMA, involve multidisciplinary research, spanning several computer sciences sub-areas. In addition there is emphasis for system-level, multilevel and multimodal approaches, encompassing modeling and measurements, and integration there-of, as well as “phenomenological” approaches, and emphasis on driving and validating the systems software advances with end-user applications the advances in computer sciences technologies.

The SMA component is aimed to enable systematic modeling and analysis methods to assist the design and management of computing systems hardware and software, and support of dynamic runtime applications environments. To enable that, the program supports development of systematic methodologies and tools for analysis and prediction of the performance of applications, of hardware platforms, and of system software. The emphasis placed in the sought methodologies is a system-level approach, so that analysis and prediction of system behavior and performance is not based on isolated components or layers but in a coherent combination of modeling, simulation, emulation of all layers and components. The approach fostered by the SMA component is to consider the computing system in terms of an architectural framework consisting of: the applications, the system software and the underlying hardware layers. Key elements of the methodologies emphasized by the SMA component, include development of multi-level and multi-modal methods and tools for describing the application software, the system software, and the system hardware. Such models and tools encompass modeling and simulation of components at multiple levels of detail and abstraction, as well as incorporation of performance measurements. Additional key capability is the ability to combine these multi-
level/multi-modal methods and tools into “performance frameworks” (in a “plug-and-play” fashion) as needed for understanding, analysis, and prediction of behavior and performance of individual components or layers as well as the system as a whole. Thus the methodology fostered by the SMA component enables component-level and system-level performance analysis and prediction.

The AES component of the program fosters novel research in two key technology areas: new compiling technology and new application composition technology, which will enable applications to effectively execute under dynamic runtime resource availability as is manifested in complex and heterogeneous grid computing environments. In the new compiling system technology advocated under AES, part of the compiler gets embedded in the runtime, and interacts with the underlying system resource managers as well as measurements and performance descriptors of the applications and the underlying hardware and software systems. This kind of new compiling system (the Runtime Compiling System – RCS) will have the ability to adaptively optimize the mapping of applications on the underlying dynamic platform assembly. In conjunction of imparting to the RCS technology the desired capabilities, the AES component also fosters the development of novel programming models, application interface, and debugging and check-pointing technologies.

In addition the program advocates the need for new technology for knowledge-based, RCS-invoked dynamic assembly of application components capabilities, to optimize composition of an application depending on the underlying resources, and supports research along these directions. The AES component also supports integration of these technologies into application support environments, and demonstration of the technologies on important production-class applications.

Through the most recent CSR Program solicitation an additional thematic area has been included (Cross-Systems Integration – CSI, in NSF07-504) placing emphasis in advances in systems software supporting dynamic integration of highly heterogeneous and environments, ranging from real-time data acquisition systems (such as sensors and other instruments) to the high-end computational grids, and driven by dynamic applications, such as those encountered in Dynamic Data Driven Applications Systems 2 3 environments.

2 Workshop Agenda

The presentations in the 2-day NGS Workshop at IPDPS2007, on March 25-26, 2007, provide a sample of the kind of research projects that are advancing technology along the directions envisioned in NGS Program, and the AES and SMA components of the CSR Program. The titles and authors of each presentation are listed below; the name underlined is that of the Principal Investigator(s) of the sponsored project. The Workshop includes in addition Panel Sessions to discuss overarching issues, broader impact, education issues, technology transfer, and potential new and additional future research directions.

Agenda for the NGS Workshop at IPDPS2007

Sunday, March 25, 2007

Session 1: 8:30am-10:30am

Introduction to the Workshop – Frederica Darema

ParalleX: A Study of A New Parallel Computation Model
Guang R. Gao, Thomas Sterling, Rick Stevens, Mark Hereld, and Weirong Zhu

Improving MPI Independent Write Performance Using A Two-Stage Write-Behind Buffering Method
Wei-keng Liao, Avery Ching, Kenin Coloma, and Alok Choudhary

Automatic MPI application transformation with ASPHALT
Anthony Danalis, Lori Pollock, and Martin Swany

Formal Analysis for Debugging and Performance Optimization of MPI
Ganesh L. Gopalakrishnan and Robert M. Kirby

Automatic Parallelization of Scripting Languages: Toward Transparent Desktop Parallel Computing

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3 www.cise.nsf.gov/dddas and www.dddas.org
Xiaosong Ma, Jiangtian Li, and Nagiza F. Samatova

**Virtual Execution Environments: Support and Tools**
Apala Guha, Jason D. Hiser, Naveen Kumar, Jing Yang, Min Zhao, Shukang Zhou, Bruce R. Childers, Jack W. Davidson, Kim Hazelwood, and Mary Lou Soffa

**Session 2: 11:00am-12:30pm**

**Intelligent Optimization of Parallel and Distributed Applications**
Bhupesh Bansal, Umit Catalyurek, Jacqueline Chame, Chun Chen, Ewa Deelman, Yolanda Gil, Mary Hall, Vijay Kumar, Taehsin Kurc, Kristina Lerman, Aiichiro Nakano, Yoon-ju Lee Nelson, Joel Saltz, Ashish Sharma, Priya Vashishta

**Scheduling issues in optimistic parallelization**
Milind Kulkarni and Keshav Pingali

**New Results on the Performance Effects of Autocorrelated Flows in Systems**
Evgenia Smirni, Qi Zhang, Ningfang Mi, Alma Riska, and Giuliano Casale

Pilsung Kang, Mike Heffner, Joy Mukherjee, Naren Ramakrishnan, Sriram Parthasarathy, Cal Ribbens, and Danesh K. Tafti

**DOSA: Design Optimizer for Scientific Applications**
David A. Bader and Viktor K. Prasanna

**The TMO Scheme for Wide-Area Distributed Real-Time Computing and Distributed Time-Triggered Simulation**
K. H. (Kane) Kim and Stephen W. Jenks

**Session 3: 1:30pm-3:30pm**

**Adaptive Scheduling with Parallelism Feedback**
Kunal Agrawal, Yuxiong He, Wen-Jing Hsu, and Charles E. Leiserson

**Weaving Atomicity Through Dynamic Dependence Tracking**
Suresh Jagannathan

**A Key-based Adaptive Transactional Memory Executor**
Tongxin Bai, Xipeng Shen, Chengliang Zhang, William N. Scherer, Chen Ding, and Michael L. Scott

**Optimizing Sorting with Machine Learning Algorithms**
Xiaoming Li, Mar’ia Jes ’us Garzar’an, and David Padua

**Knowledge and Cache Conscious Algorithm Design and Systems Support for Data Mining Algorithms**
Amol Ghoting, Gregory Bucher, Matthew Goyder, Shirish Tatikonda, Xi Zhang, Srinivasan Parthasarathy, Taehsin Kurc, and Joel Saltz

**Memory Optimizations For Fast Power-Aware Sparse Computations**
Konrad Malkowski, Padma Raghavan and Mary Jane Irwin

**A global address space framework for locality aware scheduling of block-sparse computations**
Sriram Krishnamoorthy, Umit Catalyurek, Jarek Nieplocha, Atanas Rountev, and P. Sadayappan

**Speedup using Flowpaths for a Finite Difference Solution of a 3D Parabolic PDE**
Darrin M. Hanna, Anna M. Spagnuolo, and Michael DuChene

**Session 4: 4:00pm-6:00pm**

**NGS: Service Adaptation in Open Grid Platforms**
Krishnaveni Budati, Jinoh Kim, Abhishek Chandra, and Jon Weissman

**Creating a Robust Desktop Grid using Peer-to-Peer Services**
Jik-Soo Kim, Beomseok Nam, Michael Marsh, Peter Keleher, Bobby Bhattacharjee, Derek Richardson, Dennis Wellnitz, and Alan Sussman

**Locality-aware Buffer Management: Algorithms Design and Systems Implementation for Data Intensive Applications - A Brief Progress Report**
Xiaodong Zhang

**Designing Efficient Systems Services and Primitives for Next-Generation Data-Centers**
K. Vaidyanathan, S. Naravula, P. Balaji, and D. K. Panda

**Supporting Quality of Service in High-Performance Servers**
Yan Solihin, Fei Guo, Seongbeom Kim, and Fang Liu

**Enhancing Energy Efficiency in Multi-tierWeb Server Clusters via Prioritization**
Tibor Horvath, Kevin Skadron, and Tarek Abdelzaher

**Autonomic Power and Performance Management for Large Scale Data Centers**
Bithika Khargharia, Salim Hariri, Ferene Szidarovszky, Hesham El-Reewin, Manal Houri, Samee Khan, Ishfaq Ahmad, and Mazin S. Yousif

**Improving Data Access Performance with Server Push Architecture**
Xian-He Sun, Surendra Byna, and Yong Chen
Session 5: 7:30pm-9:00pm
Panel Discussion: Programmatic Directions

Monday, March 26, 2007

Session 6: 8:30am-10:00pm
SimX meets SCIRun: A Component-based Implementation of a Computational Study System
Siu-Man Yau, Eitan Grinspun, Vijay Karamcheti, and Denis Zorin

VIPprof: Vertically Integrated Full-System Performance Profiler
Hussam Mousa, Chandra Krintz, Lamia Youseff, and Rich Wolski

Model Predictive Control for Memory Profiling
Sean Callanan, Radu Grosu, Justin Seyster, Scott A. Smolka, and Erez Zadok

Understanding Measurement Perturbation in Trace-based Data
Todd Mytkowicz, Amer Diwan, Matthias Hauswirth, and Peter F. Sweeney

PROTOFLEX: FPGA-accelerated Hybrid Functional Simulator
Eric S. Chung, Eriko Nurvitadhi, James C. Hoe, Babak Falsafi, and Ken Mai

Models and Heuristics for Robust Resource Allocation in Parallel and Distributed Computing Systems
David L. Janovy, Jay Smith, Howard Jay Siegel, and Anthony A. Maciejewski

Session 7: 10:30am-12:30pm
Model-Driven Performance Analysis Methodology for Distributed Software Systems
Swapna S. Gokhale, Aniruddha Gokhale, Jeff Gray, Paul Vandal, Dimple Kaul, Arundhati Kogekar, and Yuehua Lin

J-Sim: An Integrated Environment for Simulation and Model Checking of Network Protocols
Ahmed Sobeih, Mahesh Viswanathan, Darko Marinov, and Jennifer C. Hou

Early Results with Precision Abstraction: Using Data-flow Analysis to Improve the Scalability of Model Checking
Adam Brown, James C. Browne, and Calvin Lin

Static Verification of Design Constraints and Software Correctness Properties in the Hob System
Patrick Lam, and Martin Rinard

ExPert: Dynamic Analysis Based Fault Location via Execution Perturbations
Neelam Gupta and Rajiv Gupta

An Analysis of Availability Distributions in Condor
Rich Wolski, Daniel Nurmi Kim, John Brevik

Identifying and Addressing Uncertainty in Architecture-Level Software Reliability Modeling
Leslie Cheung, Leana Golubchik, Nenad Medvidovic, Gaurav Sukhatme

A Markov Reward Model for Software Reliability
YoungMin Kwon and Gul Agha

Session 8: 1:30pm-3:00pm
Modeling Modern Micro-architectures using CASL
Edward K. Walters II, J. Eliot B. Moss, Trek Palmer, Timothy Richards, and Charles C. Weems

Rethinking Automated Synthesis of MPSoC Architectures
Brett H. Meyer and Donald E. Thomas

A Reconfigurable Chip Multiprocessor Architecture to Accommodate Software Diversity
Engin Ipek, Meyrem Kirman, Nevin Kirman, and Jos’e F. Mart’inez

Scalable, Dynamic Analysis and Visualization for Genomic Datasets
Kai Li, Matthew Hibbs, Grant Wallace Maitreya Dunham, Rachel Sealfon, and Olga Troyanskaya

A Distributed Execution Environment for Large Data Visualization
Jian Huang, Huadong Liu, Micah Beck, Jinhua Gao, and Terry Moore

Annotation Integration and Trade-off Analysis for Multimedia Applications
Radu Cornea, Alex Nicolau, and Nikil Dutt

Session 10: 3:30pm-5:00pm
Panel Discussion: Research, Technology and Education Drivers and Opportunities (Industry Representatives)

Session 9: 5:00pm-5:30pm
Closing Discussion

Adjournment: 5:30pm