The Next Generation Software Workshop

Frederica Darema

Computer and Information Science and Engineering Directorate

National Science Foundation

Arlington, VA 22230

(darema@nsf.gov)

Abstract

This workshop provides a forum for an overview, project presentations, and discussion of the research fostered and funded by the NSF Next Generation Software (NGS) Program, and the Advanced Execution Systems (AES) and the Systems Modeling and Analysis (SMA) components of the follow-up Computer Systems Research (CSR) Program[1]. The present Workshop is part of the Next Generation Software workshop series that started in 2001 and has been conducted yearly 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: systems modeling, analysis and performance engineering methods, 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 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)

---

[1] The NSF Next Generation Software (NGS) Program was developed and managed by F. Darema. This Program Announcement and the list of current awards can be found at: http://www.nsf.gov/cgi-bin/getpub?nsf00134, and under the Next Generation Software (NGS) Program in http://www.nsf.gov/home/grants awards.htm. The two components (TPES and CADSS) of the NGS program have been incorporated in the subsequently announced Computer Systems Research (CSR) Program (NSF04-609, and NSF05-629 (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13385&org= CNS) respectively as the SMA and AES components.

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 in driving and validating 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 <u>and</u> 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.

2 Workshop Agenda

The presentations in the 2-day NGS Workshop at IPDPS2006, on April 25 and 26, 2006, 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 of the sponsored project. The Workshop includes in addition Panel Sessions to discuss overarching issues, and potential new and additional future research directions.

Agenda for the NGS Workshop at IPDPS2006

Tuesday, April 25, 2006

Session 1: 8:00am-10:00am

Introduction – Frederica Darema

Techniques and Tools for Dynamic Optimization
Jason D. Hiser, Naveen Kumar, Min Zhao, Shukang Zhou, Bruce R. Childers, Jack W. Davidson, Mary Lou Soffa

Program Phase Detection and Exploitation
Chen Ding, Sandhya Dwarkadas, Michael C. Huang, Kai Shen, John B. Carter
An Overview of the ECO Project
Jaqueline Chame, Chun Chen, Pedro Diniz, Mary Hall, Yoon-Ju Lee, Robert Lucas

Dynamic Program Phase Detection in Distributed Shared-Memory Multiprocessors
Engin Ipek, Jose F. Martýnez, Bronis R. de Supinski, Sally A. McK McKee, Martin Schulz

Session 2: 10:30am-12:10pm

Hierarchically Tiled Arrays for Parallelism and Locality
Jia Guo, Ganesh Bikshandi, Daniel Hoeflinger, Gheorghe Almasi, Basilio Fraguela, Marýa Jesus Garzaran, David Padua, Christoph von Praun

Hierarchical Multithreading: Programming Model and System Software
Guang R. Gao, Thomas Sterling, Rick Stevens, Mark Hereld, Weirong Zhu

Recent Advances in Checkpoint/Recovery Systems
Greg Bronevetsky, Rohit Fernandes, Daniel Marques, Keshav Pingali and Paul Stodghill

Dynamic Aspects for Runtime Fault Determination and Recovery
Jeremy Manson, Jan Vitek, Suresh Jagannathan

Session 3: 1:30am-3:10pm

An Extensible Global Address Space Framework with Decoupled Task and Data Abstractions
Sriram Krishnamoorthy, Umit Catalyurek, Jarek Nieplocha, Atanas Rountev, P. Sadayappan

Toward Reliable and Efficient Message Passing Software Through Formal Analysis
Ganesh Gopalakrishnan , Robert M. Kirby

Compiler-Assisted Software Verification Using Plug-Ins
Sean Callanan, Radu Grosu, Xiaowan Huang, Scott A. Smolka, Erez Zadok

An Overview of the Jahob Analysis System Project Goals and Current Status
Viktor Kuncak , Martin Rinard

Session 4: 3:30am-5:00pm

Verification of Software via Integration of Design and Implementation
Andrew S. Miner, Samik Basu

Unification of Verification and Validation Methods for Software Systems: Progress Report and Initial Case Study Formulation
James C. Browne, Calvin Lin, Kevin Kane, Yoonsik Cheon, Patricia Teller

Vision for Liquid Architecture
Roger D. Chamberlain, Ron K. Cytron, Jason E. Fritts, and John W. Lockwood

Statistical Sampling of Microarchitecture Simulation
Thomas F. Wenisch, Roland E. Wunderlich, Babak Falsafi, James C. Hoe

Session 5: 5:00am-6:00pm
Panel Discussion

Wednesday, April 26, 2006

Session 6: 10:30am-12:00pm

Designing Next Generation Data-Centers with Advanced Communication Protocols and Systems Services
P. Balaji, K. Vaidyanathan, S. Narravula, H. -W. Jin, D. K. Panda

I/O Conscious Algorithm Design and Systems Support for Data Analysis on Emerging Architectures
G. Buehrer, A. Ghoting, Xi Zhang, S. Tatikonda, S. Parthasarathy, T. Kurc, and J. Saltz

Virtual Playgrounds: Managing Virtual Resources in the Grid
K. Keahey, J. Chase, I. Foster

The GHS Grid Scheduling System: Implementation and Performance Comparison
Ming Wu, Xian-He Sun

Session 7: 1:30pm-3:00pm

Memory Optimizations for Tuned Scientific Applications: An Evaluation of Performance-Power Characteristics
Konrad Malkowski, Ingyu Lee, Padma Raghavan, Mary Jane Irwin

An Automated Approach to Improve Communication-Computation Overlap in Clusters
Lewis Fishgold, Anthony Danalis, Lori Pollock, Martin Swany

Decentralized Runtime Analysis of Multithreaded Applications
Koushik Sen, Abhay Vardhan, Gul Agha, Grigore Rosu

Session 8: 3:30pm-5:00pm

Aligning Traces for Performance Evaluation
Todd Mytkowicz, Amer Diwan, Matthias Hauswirth, Peter F. Sweeney

Model-driven Generative Techniques for Scalable Performability Analysis of Distributed Systems
Arundhati Kogekar, Dimple Kaul, Aniruddha Gokhale, Paul Vandal, Upsorn Praphamontripong, Swapna Gokhale, Jing Zhang, Yuehua Lin, Jeff Gray

Engineering Reliability into Hybrid Systems via Rich Design Models: Recent Results and Current Directions
Somo Banerjee, Leslie Cheung, Leana Golubchik, Nenad Medvidovic, Roshanak Roshandel, Gaurav Sukhatme

Session 9: 5:00am-6:00pm
Panel Discussion

Adjournment: 6:00pm