Toward Smart Supercomputing via Active Learning and Intelligent Scheduling

Zhiling Lan

Dept. of Computer Science
Illinois Institute of Technology
lan@iit.edu
Self Introduction

- Zhiling Lan
  - Ph.D., Northwestern University, 2002
  - Associate professor, Dept. of CS, Illinois Inst. of Tech.
  - Guest research faculty at Argonne Leadership Computing Facility

- Research areas:
  - Parallel and Distributed Systems
  - Supercomputing

- Research group: Scalable Computing Software Laboratory (SCS)

- Research website: http://www.cs.iit.edu/~lan
Supercomputing

- Use of supercomputers for running advanced applications efficiently, reliably and quickly
  - A supercomputer is a high-end computer with extremely fast processing capabilities, usually contains a large number of processors
  - Typical applications are programs from the fields of science and engineering, such as cosmological modeling, molecular dynamics, etc.
  - Parallel processing is often used to divide large problem into smaller ones so that they can be solved concurrently (“in parallel”)
Research Interests

- Ever-growing supercomputers (http://www.top500.org)
  - TOP500: 28 petaflops machines by Nov., 2012
    - Titan (27 PFlops), Sequoia (20 Pflops), K (11 PFlops), Mira (10 Pflops), ...
- Open issues/challenges
  - Increasing concern of data movement
  - Growing demand for energy efficiency
  - Dramatic need for reliability management
  - Dynamic performance-energy-reliability (P-E-R) control
- Research interests:
  - Data-driven intelligence, fault tolerance, resource management and scheduling, power and energy awareness, performance analysis and modeling
My Research Highlight

Dynamically control Performance-Energy-Reliability Tradeoffs

Intelligent Scheduling
- Topology-aware scheduling
- Power-aware scheduling
- Reliability-aware scheduling

Active Learning
- Fault/error/failure patterns
- Power/energy distributions
- P-E-R correlations

User Jobs

Compute Components
Active Learning

- Data are often collected from systems and applications
  - RAS events, environmental data, workload trace, performance data
- Explore data mining and machine learning to extract useful P-E-R knowledge out of huge amounts of data
- Objectives:
  - Performance characteristics
  - Fault/error/failure patterns
  - Power/energy usage and distribution
  - Correlation and tradeoffs
Intelligent Scheduling

- Act on the insights obtained from active learning

Objectives:
  - Reliability-aware scheduling
  - Power-aware scheduling
  - Topology-aware scheduling

Reliability-aware scheduling
  - Integrate failure prediction and fast detection into resource management and scheduling system
  - Apply different recovery plans for jobs with different priorities
  - Spare node management, job coordination, recovery coordination,...
Summary

- Actively extract important P-E-R knowledge out of huge amounts of system and application data
- Drive intelligent resource allocation and job scheduling for improving P-E-R

The relevant papers are available at http://www.cs.iit.edu/~lan/publications.html