

NSF Workshop on Science of Power Management

**April 9 – 10, 2009
Westin Arlington**

Purpose

- Fundamental advances required to understand power/thermal issues from chips to large distributed computing ensembles and exploit them to maximize energy efficiency while meeting required performance/reliability constraints

Organization & Funding

■ Organizing Committee

- Kirk Pruhs, University of Pittsburgh
- Kirk Cameron, Virginia Tech
- Partha Ranganathan, Hewlett-Packard
- Sandy Irani, University of California-Irvine
- David Brooks, Harvard University

■ Funding

- OCI, CISE/CNS, CISE/CCF

Agenda Overview

- Opening Remarks
 - Jeannette Wing (CISE Assistant Director, NSF)
 - Taieb Znati (CNS Division Director, NSF)
- Logistics
 - Expert Talks
 - Spotlight Talks
 - Breakout Session 1
- Dinner Reception at Rock Bottom Restaurant and Brewery

Logistics

(To be covered after Ty Znati's intro)

Detailed Agenda (Day 1)

- Opening Remarks
- Expert Talks (Now thru 14:30 including breaks)
 - **Larry Smarr** (UCSD)
 - **Partha Ranganathan** (HP)
 - **Dan Reed** (Microsoft)
 - **Rajesh Gupta** (UCSD)
 - **Kirk Pruhs** (University of Pittsburgh)
- Selected Spotlight Talks (14:30 – 15:30)
 - 6 presentations
- Breakout Session 1 (16:00 – 18:30)

Detailed Agenda (Day 2)

- Continental Breakfast (8:15 – 8:45)
- Briefings by program directors (8:45 – 9:15)
- Breakout sessions
 - Breakout Session 2 (9:15 – 10:30)
 - Breakout Session 3 (11:00 – 12:00)
- Presentations by breakout leaders (12:00 – 13:00)
- Final remarks

Breakout Groups

- Groups based on 5 focus areas
 - Hardware & architecture
 - Software and middleware
 - Networking
 - Storage
 - Physicals
- Attendees → groups based on expertise
 - Some load balancing
 - Let us know if we really goofed!
- Subgroups
 - 2-3 subgroups per group, mostly random
 - Each subgroup covers the same area (independent!)
 - Moderated by a leader

Breakout Logistics

■ Day 1

- Joint session at 16:00 (~20 mins)
 - Group objectives & expected outcomes
 - Breakup into subgroups
- Session 1 (until 18:30)
 - 11 subgroups meeting in EH1, EH2 & EH3

■ Day 2

- Joint session at 9:15 (~5 mins)
- Session 2 (individual subgroups)
- Session 3 (Joint group level)
- Presentations by group leaders
 - Both subgroup level and filtered group level

Dinner (04/09, 19:00)



Breakout Groups

(To be covered at 16:00 joint session)

Hardware Group

- Divided into 3 subgroups, each w/ 6-7 people.
- Focused on new science to address power/thermal design and corresponding performance and reliability tradeoffs from transistors to SMPs
- Potential areas to cover
 - Approaching the fundamental limits (switching speed, operating voltage, current densities, process control, etc.)
 - Low power architecture and technologies (including computation, interconnect & memory)
 - HW/FW level power/thermal management & their scalability challenges
 - Cross layer issues including HW-FW-SW interaction

SW/Middleware Group

- Divided into 3 subgroups, each w/ 5-6 people.
- Focused on new science to address intelligent power/thermal management from driver to distributed data center level.
- Potential areas to cover
 - Power/performance tradeoffs (including complexity and bounds).
 - Coordinated multi-level power/thermal control
 - Power/thermal metrics, measurement & control in large virtualized environments
 - HW-MW and MW-physical's interactions and smart power/cooling/load control.

Networking Group

- Divided into 2 subgroups, each w/ 6-7 people.
- Focused on new science to address power/thermal issues associated with communication medium from core interconnects to data center fabrics to Internet infrastructure.
- Potential areas to cover
 - Low power design and power/thermal management of intra-chip and inter-chip interconnects.
 - Computation vs. communication & power vs. latency/performance tradeoffs
 - Smart fabrics (data center, wireless, wired, ...)
 - New networking technologies & protocols

Storage Group

- Divided into 2 subgroups, each w/ 6-7 people.
- Focused on new science to address power/thermal issues associated with storage, file systems and databases.
- Potential areas to cover
 - Power/thermal management of storage devices and hierarchies (including tape, disk, NVRAM, ...)
 - Low power file and database systems
 - Power related database tradeoffs (accuracy, precision, consistency, timeliness, ...)
 - Novel storage & retrieval technologies

Physical Issues

- Divided into 2 subgroups, each w/ 4-5 people.
- Focused on new science to address intelligent management of power conversion, distribution and delivery, and cooling at all levels from chips to data center.
- Potential areas to cover
 - Power conversion and distribution issues at data center, rack, board and chip level including “smart” power supplies, VRs, etc.
 - Smart cooling/thermal technologies and control from chip to data center level (including ambient, forced air & liquid cooling)
 - Thermal enclosure design
 - Power supply side issues from smart batteries to smart grid.
 - Power/thermal/cooling faults (e.g., emergency rideout)

Outcomes

- Each subgroup generates a list of major outstanding issues and potential approaches.
- Multiple subgroups within a group may come up with different & sometimes conflicting items.
- Group level meetings expected to
 - Resolve conflicts (to the extent possible)
 - Bubble up most significant issues to the top