Energy Efficient HPC Working Group

Natalie Bates

8th Annual Workshop

AGENDA:

- Team reports –
- EEHPCWG Next Steps and Direction – Where to next
- SC Primer – what else to do… BoF, Panels
- Industry Links, Activities, and Collaboration
  - ASHRAE TC9.9, The Green Grid, Top 500, Green 500, PRACE

OBJECTIVE:

- Encourage participation in EE HPC WG

TEAM REPORTS:

- David Grant, Oak Ridge National Laboratory
- Dale Sartor, Lawrence Berkeley National Laboratory
- David Martinez, Sandia National Laboratory
- Anna Maria Baily, Lawrence Livermore National Laboratory
- Michael Patterson, Intel Corporation
- Suzanne Rivoire, Sonoma State University
- Torsten Wilde, Leibniz Supercomputing Center
- Kevin Pedretti, Sandia National Laboratory
- Steve Martin, Cray Inc.

Liquid Cooling Controls

David Grant, ORNL

- Impacts of the work
  - Increase ease of deployment for liquid cooling controls
  - Improve energy efficiency of the cooling system and reduce costs of cooling
- Deliverables
  - “EE HPC WG Liquid Cooling Controls Team Whitepaper”; https://eehpcwg.llnl.gov/pages/infra_ctrls.htm ; 2017.
  - State of the practice case studies for liquid cooling control systems
- Current activities
  - Discussions with ASHRAE, Redfish and Power API on incorporating these data inputs in their recommendations
- Next steps
  - Inclusion of data inputs in ASHRAE, Redfish and Power API & EE HPC WG Procurement Considerations Document 2017
  - Total Cost of Ownership and HPC System Procurement BoF; Tuesday 12:15
  - Redfish, PowerAPI and GEOPM BoF; Tuesday 17:15
- Help needed
  - Advocates for EE HPC WG to work on Redfish and Power API Committees
  - Contribute case studies and lessons learned

Liquid Cooling “Standards”

Dale Sartor, LBNL

- Impacts of the work
  - Encourage liquid-cooled solutions that do not require compressors
  - Increase ease of deployment by “standardizing” facility and HPC equipment
  - Set the bar for more opportunities to reuse waste heat
- Deliverables
  - Wx temperature classes developed, presented, and published (e.g. SC11), and included in ASHRAE TC9.9 Liquid Cooling Guidelines for Datacom Equipment Centers.
- Current activities
  - EEHPCWG members providing input and expertise to develop “open” specification for warm water liquid cooled rack with major internet companies
- Next steps
  - Continue to communicate and clarify Wx recommendations
  - Provide input to liquid cooled rack specification harmonizing U.S. and Chinese standards (e.g., OCP and Scorpio)
- Help needed
  - Input on draft specifications including fluid and connectors as well as operating conditions (e.g. temperatures and pressure)

Liquid Cooling Commissioning

Dave Martinez, Sandia NL

- Impacts of the work
  - Encourage decreased costs and improve energy efficiency with effective liquid cooling commissioning
- Deliverables
  - "Systematic approach for commissioning liquid cooling infrastructure to support liquid cooled HPC systems"; https://eehpcwg.llnl.gov/pages/infra_lccs.htm . 2015.
  - State of the practice case studies for liquid cooling commissioning
- Current activities
  - Include recommendations in EE HPC WG Procurement Considerations Document 2017
- Next steps
  - Total Cost of Ownership and HPC System Procurement BoF; Tuesday 12:15
  - ASHRAE TC9.9 to incorporate liquid cooling commissioning in commissioning guideline
- Help needed
  - Technical expert w/strong technical writing skills to finalize whitepaper with ASHRAE TC9.9 Committee
  - Contribute case studies and lessons learned

RAS and Maintainability

Anna Maria Bailey, LLNL

- Impacts of the work
  - Increase energy and operational efficiency by improving Reliability Availability Serviceability (RAS) and Maintainability beyond the HPC system to facility infrastructure
- Deliverables
  - Questionnaire created and sent to major US supercomputing sites
  - (4) responses indicate reliability, availability, serviceability (maintainability) extends beyond the systems
- Current activities
  - Soliciting feedback on team creation from major US supercomputing sites
  - Do we create a team on HPC facility maintainability and reliability as it relates to energy efficiency and availability?
- Next steps
  - Waiting for responses
- Help needed
  - Complete the questionnaire
  - Share best practices/lessons learned

iTUE and TUE

Mike Patterson, Intel

- Impacts of the work
  - Combines with PUE to provide a TOTAL view of where the inefficiencies are. Adds a “server PUE”. Precludes miscounting power and cooling losses on the wrong side of the equation.
- Deliverables
  - “ TUE, a new energy-efficiency metric applied at ORNL's Jaguar”; Gauss Best Paper Award; ISC13 International Supercomputing Conference; Leipzig, Germany; 2013.
  - State of the practice case studies for TUE and iTUE
  - Recommended capability in EE HPC WG Procurement Considerations document
- Current activities
  - Evangelizing ITUE/TUE in talks and conferences
- Next steps
  - Develop an ITUE case studies session for next years workshop
- Help needed
  - Engage The Green Grid to promote iTUE and TUE
  - Explore your ability to measure or estimate your iTUE and TUE
  - Contribute case studies/lessons learned

Power Measurement Methodology

Suzanne Rivoire, Sonoma State

- Impacts of the work
  - Provides the functions which can monitor and record power consumption of entire system in real time
  - More accurate HPC system architectural trend data for the HPC Community
- Deliverables
  - State of the practice case studies on power measurement methodology
  - “Energy Efficient High Performance Computing Power Measurement Methodology (version 1.0)”; 2012
  - “A power-measurement methodology for large scale, high performance computing”. ACM/SPEC International Conference on Performance Engineering; 2014.
  - “Node Variability in Large-Scale Power Measurements: Perspectives from the Green500, Top500 & EE HPC WG”. SC15; 2015.
  - “Energy Efficient High Performance Computing Power Measurement Methodology (version 2.0 RC 1.0)”; https://www.top500.org/green500/resources/eehpc-wg-power-measurement-methology/; 2015.
  - “Submissions Open for Newly Merged TOP500 and Green500”; May 6, 2016; Rich Brueckner; Inside HPC.
- Current activities
  - Solicit and understand feedback on system-level workload power measurement methodology
  - Encourage L2/L3 measurement submissions to Green500/Top500
- Next steps
  - Top500/Green500 List L2/L3 Measurement feedback presented at SC17 Green500 BoF, Wednesday 17:15
- Help needed
  - Make L2/L3 measurement submissions to Top500/Green500 List
  - Encourage extension of L2/L3 measurement submissions to other benchmarks, e.g., GreenGraph500

Electric Grid Integration

Torsten Wilde, LRZ

- Impacts of the work
  - Raising awareness of evolving relationship between SCs and their Electricity Service Providers
  - The landscape is changing- get to know your ESP and their partners.
  - Implement contingency planning for power management while minimizing impact to users.
- Deliverables
  - "The Electrical Grid and Supercomputing Centers: An Investigative Analysis of Emerging Opportunities and Challenges”; Energiinformatik; Zurich, Switerland; 2014.
  - "Supercomputing Centers and Electricity Service Providers: A Geographically Distributed Perspective on Demand Management in Europe and the United States”; ISC16 International Supercomputing Conference; Frankfurt, Germany; 2016.
- Current activities
  - Writing a paper that examines electricity service contracts in major Supercomputing Centers(SC)
- Next steps
  - Finalize and publish next paper
- Help needed
  - Contribute case studies/lessons learned

EPA JSRM

Kevin Pedretti, Sandia NL

- Impacts of the work
  - Share best practices of Energy and Power Aware Job Scheduling and Resource Management (EPA JSRM) and learn from each other
  - Identify opportunities for influencing product development
- Deliverables
  - Interview results from 9 sites that have deployed or are doing technology development (TD) with the intent to deploy large scale EPA JSRM capability in a production environment
- Current activities
  - Analyzing data from survey of large scale EPA JSRM deployments
- Next steps
  - EPA JSRM Poster, EPA JSRM BoF; Wednesday 12:15, Software and Energy Efficiency Panel; Friday 10:30.
  - Whitepaper
  - Technical paper
- Help needed
  - Join the team and help with data collection, analysis and writing the paper
  - Identify other potential sites with large scale EPA JSRM in production of TD with an intent to deploy

Procurement Considerations

Steve Martin, Cray Inc.

- Impacts of the work
  - Influence product development to drive energy efficient HPC systems
- Deliverables
  - State of the practice case studies for energy efficiency considerations in procurement
  - Component and System Integrator responses to EE HPC WG Procurement Considerations
  - Energy Efficiency Considerations for HPC Procurement Documents: 2014 and Energy Efficiency Considerations for HPC Procurement Documents: 2013 https://eehpcwg.llnl.gov/pages/compsys_pro.htm
- Current activities
  - Updating procurement considerations document for 2017 with vetted material (e.g., liquid cooling controls)
  - Collaborating with PRACE (Partnership for Advanced Computing in Europe) on TCO and Procurement
- Next steps
  - Publish Energy Efficiency Considerations for HPC Procurement Documents: 2017
  - Start working on Energy Efficiency Considerations for HPC Procurement Documents: 2018
  - Total Cost of Ownership and HPC System Procurement BoF; Tuesday 12:15
- Help needed
  - Participate on the Procurement Considerations Team and help write documents
  - Share best practice procurement documents

Dashboards

Natalie Bates, EE HPC WG

- Impacts of the work
  - Strive for consensus on HPC center dashboard energy efficiency elements and metrics
- Deliverables
  - "Re-examining HPC Energy Efficiency Dashboard Elements"; 12th Workshop on High Performance Power Aware Computing
  - "General Recommendations for High Performance Computing Data Center Energy Management Dashboard Display"; 9th Workshop on High-Performance Power-Aware Computing Conference
- Current activities
  - Questionnaire - current use of dashboards at major supercomputing centers in USA, Europe & Japan
- Next steps
  - Analyze questionnaire results and write/publish paper
- Help needed
  - Participate in the Dashboard Team and help with analyzing data and writing paper

EE HPC WG Next Steps and Direction – Where to next?

- Potential New Teams
  - Maintainability
  - PowerAPI
  - Warm water cooling – rack standard
  - Facility High Voltage and Direct Current
  - Energy Re-use
  - Other Software Teams
- Expand presence from US and Europe to Japan

Industry Links and Collaborations

TOP500 SUPERCOMPUTER SITES

the green grid
get connected to efficient IT

THE GREEN 500

ASHRAE

PRACE

SC17 EE HPC WG Primer

https://eehpcwg.llnl.gov/pages/conf_sc17a.htm

Energy Efficient HPC Working Group
Super Computing Conference 2017

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Eighth Annual Workshop for the Energy Efficient … HPC WG)

Abstract:

This annual workshop is organized by the Energy Efficient HP… Work…ges th… gap between facility and IT system with regards to energy efficiency analysis and improvements… or sustainable exascale computing, powe… and energy are a main concern, which can only be addressed by taking a holistic view combi…ng the HPC facility, HPC system, HPC sy…m software, and the HPC application

Other EE HPC WG Technical Sessions

- **Research Poster: Tuesday- Thursday 8:30-5:00**
  - "Global Survey of Energy and Power-aware Job Scheduling and Reso…
- **Birds of Feather: Tuesday 12:15-1:15 Room 605**
  - "Total Cost of Ownership and HPC System Procurement"
    - Energy Efficiency Considerations for HPC Procurement Documents: 2017
    - EE HPC WG Liquid Cooling Controls Team Whitepaper. June 11, 2017
    - Systematic Approach For Universal Commissioning … For Liquid-Cooled Systems
- **Birds of Feather: Tuesday 5:15-7:00 Room 712**
  - "Power API, GEOPM and Redfish: Open Interfaces for Power/Energy Measure… …Control"
    - EE HPC WG Liquid Cooling Controls Team Whitepaper. June 11, 2017
- **Birds of Feather: Wednesday 12:15-1:15 Room 501/502**
  - "State of the Practice: Energy and Power Aware Job Scheduling and Resource Management"
    - Whitepaper: A Survey of Energy and Power Aware Job Scheduling and Resource Mana… Supercomputing Centers
- **Birds of Feather: Wednesday 5:15-7:00 Room 402/403/404**
  - "Green500: Trends in Energy Efficient Supercomputing"
    - Energy Efficient High Performance Computing Power Measurement Methodology (vers…
- **Panel: Friday 10:30-noon Room 201/203**
  - "Energy Efficiency Gains from Software: Retrospectives and Perspectives (Version 2.0 RC 1.0)
    - This panel will explore what HPC software capabilities were most helpful over the past years in improving HPC system energy efficiency? It will then look forward; asking in what layers of the software stack should a priority be put on introducing energy-awareness; e.g., runtime, scheduling, applications? What is needed moving forward? Who is responsible for that forward momentum?
    - Moderator/Panelists: Dan Reed, Satoshi Matsuoka, Sadaf Alam, Bill Gropp and John Shalf

Links to relevant BoF Documents

Discussion Groups

- Workshop Lunch
  - Liquid Cooling
  - Maintainability
  - SW and Energy Efficiency
  - System Power Measurement
- Booth #286
  - Liquid Cooling: Tuesday and Wednesday 10:30am to Noon
  - Reliability Availability Serviceability and Maintainability: Tuesday 2:00pm - 4:00pm
  - Software and Energy Efficiency: Wednesday 11:00am to Noon, 3:00pm – 4:00pm

We value your feedback!

https://www.surveymonkey.com/r/Y9F3MCN

Thank you!

http://eehpcwg.llnl.gov

natalie.jean.bates@gmail.com


E2
HPC
Working Group