
# Energy Efficient HPC Working Group

Natalie Bates

9th Annual Workshop


# AGENDA:

- Team reports –
- EE HPC WG Next Steps and Direction – Where to next?
- SC Primer – What else to do?… BoF, Panels
- Industry Links, Activities, and Collaboration

# OBJECTIVE:

- Encourage participation in EE HPC WG


TEAM REPORTS:

- Josip Loncaric, Los Alamos National Laboratory
- Ghaleb Abdulla, Lawrence Livermore National Laboratory
- Sid Jana, Intel Corporation
- Wu Feng, Virginia Tech and Green500
- Gert Svensson, KTH Swedish Royal Institute of Technology
- Dale Sartor, Lawrence Berkeley National Laboratory
- David Grant, Oak Ridge National Laboratory
- Anna Maria Baily, Lawrence Livermore National Laboratory
- Ryan Grant, Sandia National Laboratory
- Natalie Bates, EE HPC WG


# Electric Grid Integration

## Josip Loncaric, LANL

- Impacts of the work
  - Create an awareness of the contractual relationships between Electricity Service Providers and Supecomputing Centers
  - Investigate minimizing the impact of large power loads and voltage swings on electrical distribution systems
- Deliverables
  - “An Analysis of Contracts and Relationships between Supercomputing Centers and Electricity Service Providers”; pending
  - "Supercomputing Centers and Electricity Service Providers: A Geographically Distributed Perspective on Demand Management in Europe and the United States”; 2016
  - "The Electrical Grid and Supercomputing Centers: An Investigative Analysis of Emerging Opportunities and Challenges”; 2014
- Current activities
  - Gather information from LANL, NCAR/UCAR, ORNL, LLNL, ECMWF on impact of large power loads and voltage swings
- Next steps
  - Complete questionnaires/interviews, synthesize information gathered, analyze results, publish whitepaper
- Help needed
  - Additional sites to participate in questionnaire/interview
  - Expertise with electrical distribution systems and responsiveness to large power loads and voltage swings
  - Participate in Grid Integration Team


# Operational Data Analytics

Ghaleb Abdulla, LLNL

- Impacts of the work
  - Share early adopter best practices of operational data analytics for HPC data centers
  - Demonstrate value of integrated operational data analytics through usage cases
- Deliverables
  - Collected/synthesized general information on integrated data analytics from several early adopters
- Current activities
  - Gather information on other early adopters and focus on use cases and implementation challenges
- Next steps
  - Announce transition from Dashboard to Operational Data Analytics Team
  - Complete questionnaires/interviews, synthesize information gathered, analyze results, publish whitepaper
- Help needed
  - Participate in the Operational Data Analytics Team

**Data Analytics BoF**
**Thursday 12:15-1:15 D171**


# EPA JSRM

Sid Jana, EE HPC WG | Intel Corporation

- Impacts of the work
  - Share best practices of Energy and Power Aware Job Scheduling and Resource Management (EPA JSRM)
  - Identify opportunities for influencing product development
- Deliverables
  - “Energy and power aware job scheduling and resource management: Global survey initial analysis”; 2018
  - Initial analysis used as input for Powerstack Seminar; 2018
  - “Energy and Power Aware Job Scheduling and Resource Management: Global Survey — An In-Depth Analysis”; 2018
- Current activities
  - Explore motivation, requirements and vision of sites deploying EPA JSRM
- Next steps
  - Other sites to share information at EPA JSRM BoF and Team meetings.
  - Stay in touch with PowerStack and participate in PowerStack BoF; Thursday 12:15.
- Help needed
  - Participate in EPA JSRM Team

**Software & EE Panel -Thurs 10:30-noon C147**
**EPA JSRM BoF - Wednesday 12:15-1:15 D144**


# Power Measurement Methodology

## Wu Feng, Virginia Tech and Green500

- 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
  - "Energy Efficient High Performance Computing Power Measurement Methodology (version 1.0)"; 2012
  - "A power-measurement methodology for large scale, high performance computing"; 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); 2015. https://www.top500.org/green500/resources/eehpc-wg-power-measurement-methology/
  - "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
  - L2/L3 feedback at Green500 BoF
- Help needed
  - Make L2/L3 measurement submissions to Top500/Green500 List
  - Encourage extension of L2/L3 measurement submissions to other benchmarks, e.g., GreenGraph500

**Green500 BoF**
**Wednesday 17:15-18:45 D167**


# Procurement Considerations

Gert Svensson, KTH Royal Institute of Technology

- Impacts of the work
  - Influence product development for energy efficient HPC systems
  - Encourage HPC sites to consider energy efficiency during procurement of HPC systems
- Deliverables
  - Energy Efficiency Considerations for HPC Procurement Documents: first published 2013 and updated 2014 and 2017; EE HPC WG/Groups/Computing Systems/Procurement Considerations Documents
- Current activities
  - Updating procurement considerations document with a focus on improving document structure as well as major content updates to Cooling and Facility Integration
  - Collaborating with PRACE (Partnership for Advanced Computing in Europe) on TCO and Procurement
- Next steps
  - Continue working on updating Energy Efficiency Considerations for HPC Procurement Documents
- Help needed
  - Participate on the Procurement Considerations Team

**Procurement BoF**
**Tuesday 12:15-1:15 C145**


# 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
  - Input to next edition of ASHRAE TC9.9 Liquid Cooling Guidelines for Datacom Equipment Centers.
  - Input to "Open" specification for warm water liquid cooled rack
- Current activities
  - Forming Team to provide input on "open" specification for warm water liquid cooled rack specification
- Next steps
  - Announce Liquid Cooling "Standards" Team formation and solicit participants
- Help needed
  - Participate in ASHRAE TC9.9 Committee activities and coordinate with EE HPC WG
  - Participate on Liquid Cooling "Standards" Team

**Liquid Cooling BoF**
**Tuesday 17:15-18:45 C144**


# 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
  - Whitepaper: EE HPC WG Liquid Cooling Controls Team; 2017 EE HPC WG/Groups/Infrastructure/Controls
  - Presented to PowerAPI and put in their queue for future attention
  - ASHRAE included data inputs for HPC systems in their recommendations to Redfish
- Current activities
  - Discussions with Redfish and Power API on incorporating these data inputs
- Next steps
  - Inclusion of data inputs in ASHRAE, Redfish and Power API
- Help needed
  - Advocates for EE HPC WG liquid cooling controls to work on Redfish and Power API Committees


# Power API

Ryan Grant, Sandia National Laboratories

- Impacts of the work
  - Ease of deployment
  - Cost reduction
- Deliverables
  - Comprehensive specification that covers multiple interfaces for many roles/levels of system
  - Reference implementation, a community effort – multiple stakeholders
- Current activities
  - Soliciting feedback and queue of recommendations
  - Re-engineering portions of the reference implementation
- Next steps
  - Next version of the specification
- Help needed
  - Participate in PowerAPI Team – Specification and implementation - **https://eehpcwg.llnl.gov/power-api.html**
  - Ask for PowerAPI compliance

**Power API and Redfish BoF**
**Wednesday 12:15-1:15 D227**


# RAS and Maintainability

Anna Maria Bailey, LLNL

- Impacts of the work
  - Increase energy and operational efficiency by improving Reliability Availability Serviceability and Maintainability (RAS-M) beyond the HPC system to facility infrastructure
- Deliverables
  - (8) major US Supercomputing sites respond to questionnaire on RAS and maintainability
  - Decision to create RAS-M Team
- Current activities
  - Forming RAS-M Team with deliverables to 1) define metrics, 2) document best practices for bringing together diverse groups of people for RAS-M and 3) document best practices for predictive and condition based preventative maintenance
- Next steps
  - Announce RAS-M Team formation and solicit participants
- Help needed
  - Participate on the RAS-M Team
  - Share best practices/lessons learned


# Dashboards

## Natalie Bates, EE HPC WG

- Impacts of the work
  - Strive for consensus on HPC center dashboard energy efficiency elements and metrics
- Deliverables
  - Whitepaper: Current Use Dashbaords Survey; 2017. EE HPC WG/Groups/Infrastructure/Dashboard
  - "Re-examining HPC Energy Efficiency Dashboard Elements"; 2016
  - "General Recommendations for High Performance Computing Data Center Energy Management Dashboard Display"; 2013
- Current activities
  - Transitioning team to focus on operational data analytics – the stuff behind dashboards
- Next steps
- Help needed

# Liquid Cooling Commissioning

## Natalie Bates, EE HPC WG

- Impacts of the work
  - Encourage decreased costs and improve energy efficiency with effective liquid cooling commissioning
- Deliverables
  - Whitepaper: Systematic approach for commissioning liquid cooling infrastructure to support liquid cooled HPC systems; 2015. EE HPC WG/Groups/Infrastructure/Liquid Cooling Commissioning
- Current activities
- Next steps
  - ASHRAE TC9.9 to incorporate liquid cooling commissioning in commissioning guideline
- Help needed
  - Include commissioning as part of your HPC system procurement considerations
  - Technical expert w/strong technical writing skills to finalize whitepaper with ASHRAE TC9.9 Committee


# iTUE and TUE

## Natalie Bates, EE HPC WG

- 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”; 2013.
- Current activities
- Next steps
- Help needed
  - Ask HPC vendor for capability to measure iTUE
  - Explore your ability to measure or estimate your iTUE and TUE and contribute case studies/lessons learned


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

New Teams

- RAS and Maintainability
- Warm water cooling – rack standard collaboration
- PowerStack collaboration

Continue to build presence in Japan

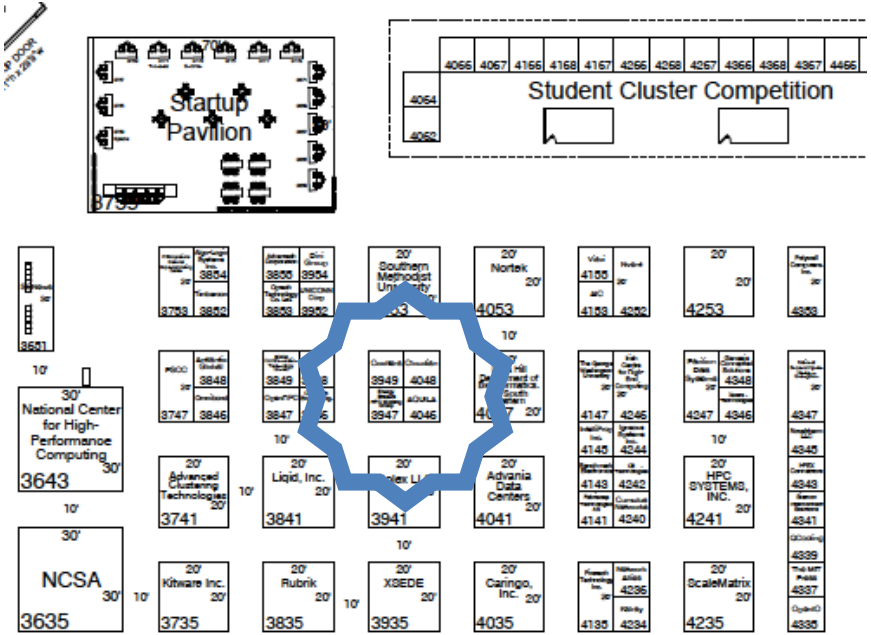
# Industry Links, Activities and Collaborations

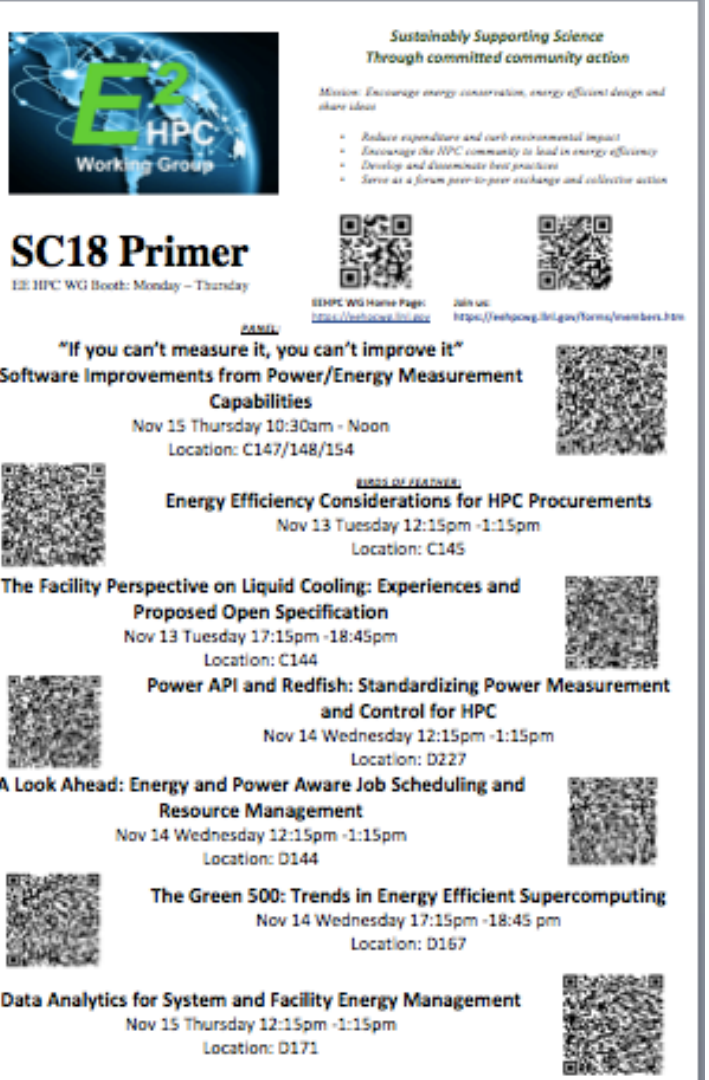
Top 500, Green 500, ASHRAE, The Green Grid, PowerAPI, Redfish, PRACE, PowerStack, Liquid Cooling Rack Standard

# EE HPC WG at SC18

Join us for Panels and BoFs

Visit us at Booth 3947



Sustainably Supporting Science Through committed community action

Mission: Encourage energy conservation, energy efficient design and share ideas

- Reduce expenditure and curb environmental impact
- Encourage the HPC community to lead in energy efficiency
- Develop and disseminate best practices
- Serve as a forum peer-to-peer exchange and collective action

## SC18 Primer

EE HPC WG Booth: Monday – Thursday

EEHPC WG Home Page: https://eehpcwg.lbl.gov

Join us: https://eehpcwg.lbl.gov/forms/members.htm

PANEL

**"If you can't measure it, you can't improve it" Software Improvements from Power/Energy Measurement Capabilities**

Nov 15 Thursday 10:30am - Noon

Location: C147/148/154

BIRDS OF FEATHER

**Energy Efficiency Considerations for HPC Procurements**

Nov 13 Tuesday 12:15pm -1:15pm

Location: C145

**The Facility Perspective on Liquid Cooling: Experiences and Proposed Open Specification**

Nov 13 Tuesday 17:15pm -18:45pm

Location: C144

**Power API and Redfish: Standardizing Power Measurement and Control for HPC**

Nov 14 Wednesday 12:15pm -1:15pm

Location: D227

**A Look Ahead: Energy and Power Aware Job Scheduling and Resource Management**

Nov 14 Wednesday 12:15pm -1:15pm

Location: D144

**The Green 500: Trends in Energy Efficient Supercomputing**

Nov 14 Wednesday 17:15pm -18:45 pm

Location: D167

**Data Analytics for System and Facility Energy Management**

Nov 15 Thursday 12:15pm -1:15pm

Location: D171


# Informal Discussions and Networking

- Today, after you get your lunch
  - Liquid Cooling; Dale Sartor and Dave Martinez
  - Software and Energy Efficiency; Sid Jana and Ryan Grant
  - Measuring, monitoring and managing; Torsten Wilde and Ghaleb Abdulla


The EE HPC WG values your feedback

- A question for each session today
- Please help us make next year even better!

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

# Thank you!

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E2
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Working Group