

**Energy Efficient High Performance Computing Working Group
6/13/17 Meeting Report**

INTRODUCTION

The EE HPC WG held a meeting on 6/13/17. This Working Group is composed of members representing major Federal departments and independent agencies, private sector representatives, and members of the academic community. More information can be found at the working group's website, <https://eehpcwg.llnl.gov/> .

NEXT MEETING: Tuesday August 8th, 9:00-10:00AM Pacific Time

Introductions and Announcements: *Natalie Bates, EE HPC WG & Anna Maria Bailey, LLNL*

Vladimir Getov announced an October 2016 IEEE book publication with multiple articles on energy efficiency and computing.

TITLE: New Frontiers in Energy-Efficient Computing

ABSTRACT: Energy-efficient computing remains a critical challenge across the wide range of future data-processing engines — from ultra-low-power embedded systems to servers, mainframes, and supercomputers. In addition, the advent of cloud and mobile computing as well as the explosion of IoT technologies have created new research challenges in the already complex, multidimensional space of modern and future computer systems. These new research challenges led to the establishment of the IEEE Rebooting Computing Initiative, which specifically addresses novel low-power solutions and technologies as one of the main areas of concern. With this in mind, we thought it timely to survey the state of the art of energy-efficient computing.

<http://ieeexplore.ieee.org/abstract/document/7598170/>

Conferences Sub-group Update: *Torsten Wilde, Leibniz Supercomputing Centre (LRZ, Germany) & Michael Patterson, Intel*

SC17

SC17 will be held in Denver, Colorado from November 12 through the 17th. The EE HPC WG is planning on having a presence again at SC17.

- We have already reserved space on the floor for a booth.
- The Annual EE HPC WG Workshop has been accepted and will be held all day on Sunday, November 12th.
- We just received word that our panel submission was accepted. This panel will be on energy-efficiency gains to be had from applications and associated high-level software. The moderator will be Dan Reed, from the University of Iowa. Panelists

include Satoshi Matsuoka from the Tokyo Institute of Technology, John Shalf from LBNL and Thomas Schulthess from the Swiss National Supercomputing Center.

- We will be making several BoF submissions and they are due July 31st.

ISC17

ISC17 will be held in Frankfurt, Germany next week, from June 18th through the 22nd. The EE HPC WG will participate in two ISC17 events; a BoF and a panel. Planning is underway.

The BoF is scheduled for Tuesday, 20 June and will be a joint EE HPC WG, Green500 and Top500 BoF with an emphasis on hearing feedback from the community about the system level power measurement methodology for use when running a workload.

On Wednesday, 21 June, there will be a panel on Energy Efficiency in HPC. Panelists will include Jonathan Eastep from Intel, Martin Shultz from LLNL, Daniel Hackenberg from University of Dresden and Torsten Wilde from LRZ. This panel will present the state of the art in energy efficiency research from the perspectives of academia, industry and government, and spanning both hardware and software. The aim of the panel will be to stimulate a discussion around the effectiveness of current energy management and energy efficiency techniques that are deployed across the entire system.

EnaHPC

The Energy Aware High Performance Computing Workshop will be held in conjunction with the International Supercomputing Conference in Frankfurt, Germany. It is scheduled for Thursday, 22 June.

A power/energy tutorial will be held at **HPCS** 2017 (<http://hpcs2017.cisedu.info/>) in Genoa, Italy.

Other Conferences

The EE HPC WG website has a links and events page with many other conferences and workshops listed that have an HPC energy efficiency focus.

Infrastructure Sub-Group Update: *David Grant, ORNL and Dave Martinez, SNL*

LIQUID COOLING CONTROLS TEAM:

Background: The Liquid Cooling Controls Team has defined data inputs for dynamic controls to manage liquid cooling control systems, both with the facility and the HPC system. They have identified a short list of data inputs. These data elements and their characteristics are being described for a particular use case; that of dynamic liquid cooling control. Each data input is described with a name and the unit of measurement. There are also characteristics of the measurement; where it is taken, whether the measurement capability is provided by the facility

or the IT system or either one, the frequency with which the measurement is taken and the accuracy of the measurement capabilities.

News: The Team has just published this guideline as a whitepaper for sites to use when designing dynamic controls for liquid cooling systems. The Team is now approaching other organizations, such as ASHRAE, Redfish, GEOPM and Sandia's Power API to see if they might be interested in collaborating with helping to promote these recommendations. They will also be working with the EE HPC WG Procurement Considerations Team to see about including these as part of the next Procurement document.

DASHBOARD TEAM:

Background: The Dashboard Team has published guidelines on general recommendations for selecting energy efficiency elements of HPC data center dashboards. A dashboard is a display that is used to provide critical feedback to the users. Carefully selecting the elements to be displayed on the energy dashboard is important, as energy management is a shared responsibility of all stakeholders: operations managers, facilities managers, and system administrators.

News: The Dashboard Team has developed a questionnaire to collect the current information on the use of Dashboards in HPC data centers. The dashboard team will use the data to help better achieve the two goals of the team based on factual data, user's feedback on current use of energy dashboards and its potential future use.

Dashboard Team goals are noted below:

1. Continue to refine the guideline on general recommendations for selecting energy efficiency elements of HPC center dashboards,
2. Research and investigate the extension potentials of furthering the use of dashboard technology for HPC centers to predict energy consumption and operational energy management.

There will be three categories of open ended questions in support of these two goals:

- Current use of dashboard systems,
- Dashboard meeting user's current expectations and per guidelines
- What the future new expectations of these systems could be.

The dashboard team plans to publish a summary and some analysis of all responses. The team will also plan to publish an updated General Recommendation document.

MAINTAINABILITY TEAM:

Three US Department of Energy National Laboratories (LLNL, ORNL and Sandia NL) are interested in creating an EE HPC WG Team on HPC facility maintainability and reliability as it relates to energy efficiency and availability. They are investigating whether or not to create an EE HPC WG Maintainability Team and also to understand what would be the team's mission and deliverable. They have developed a questionnaire and will be using it to gauge interest in working together on reliability and maintainability as it relates to availability and energy efficiency.

TUE TEAM:

Background: The TUE Team has published a paper that defines two new metrics; iTUE and TUE that account for infrastructure elements that are a part of the HPC system (like cooling and power distribution). This is an improvement over PUE.

News: There isn't any news from the TUE Team.

LIQUID COOLED COMMISSIONING TEAM:

Background: The Liquid Cooling Commissioning Team has published a guideline that establishes the fundamentals for liquid-cooled commissioning and develops a comprehensive approach to commissioning liquid-cooled systems. It includes examples from different data center sites and the various approaches utilized in commissioning liquid-cooled solutions.

News: There isn't any news from the Liquid Cooled Commissioning Team.

LIQUID COOLING (W_x) GUIDELINE TEAM:

Background: The original Liquid Cooling Team was dub'ed the W_x Team. This Team worked collaboratively with the American Society of Heating, Refrigerating and Air-Conditioning Engineers Technical Committee 9.9 (ASHRAE TC 9.9) to develop guidelines for warmer liquid-cooling temperatures to guide future supercomputer procurements, and to facilitate the design of warmer temperature cooling systems. ASHRAE TC 9.9 (with EE HPC WG collaboration) authored a book that describes classes of typical infrastructure design and the recommended ranges for water supply temperature in each of those classes.

News: There isn't any news from the W_x Team.

High Voltage and DC- Potential New Team:

Background: For most HPC centers, power goes through multiple conversions in alternating current (AC) with a final conversion to direct current (DC) within power supplies in the HPC system. There may be opportunities for energy efficiency and reduced operational costs with fewer conversions including DC conversion at a higher voltage within the HPC center.

News: There isn't any news.

Systems Sub-group Update: *Natalie Bates, EE HPC WG*

SYSTEM WORKLOAD POWER MEASUREMENT METHODOLOGY:

Background: The Green500, Top500 and the Energy Efficient HPC Working Group have developed a methodology for measuring power while running a workload, such as High Performance Linpack (HPL). The methodology defines three quality levels; essentially a "good",

“better”, “best” with Level 3 having the highest quality. Version 1 was published in 2012. Since then, the EE HPC WG, Green500 and the Top500 have been soliciting, collecting, reviewing and responding to feedback from the broader community. This has resulted in publication of Version 2 in 2015. Version 2 includes some editorial improvements and minor changes, but was mostly focused on fixing some major issues and concerns with V1. Major issues affect the outcome, the way it is done, the intended result. There have been multiple sites that have used the Version 2 Methodology and provided feedback for changes.

News: This Team is preparing for a BoF at ISC17 next week.

This BOF will discuss trends across the Green500 and highlights from the *current* Green500 list. The Green500 and TOP500 have a newly integrated submission process designed to streamline future submissions and to provide a consistent set of data for the historical record. This BOF will also provide a forum for community review of the integrated submission process.

The Green500, Top500 and the Energy Efficient HPC Working Group have developed a methodology for measuring power while running a workload, such as High Performance Linpack (HPL). The methodology defines three quality levels; essentially a “good”, “better”, “best” with Level 3 having the highest quality. This BOF will present a review of this methodology and review feedback from sites that have made submissions that meet the “best” or Level 3 requirements. The BoF will also encourage broader evaluation and feedback on the methodology.

HPC AND GRID INTEGRATION:

Background: This team is analyzing data from 10 major supercomputing centers in Europe and the United States about their electricity contracts and relationships with their electricity service providers. The goal of this study is to determine the structure of the contracts that exist between supercomputing centers and electricity service providers. The team is identifying the influence that this interaction (contractual interaction) may have on demand flexibility. This information is used to understand the degree to which supercomputing centers have, and manage, flexibility toward grid operation. The information will be further used to identify barriers and opportunities in a demand response-participation context.

News: The Team has made substantial progress with analyzing the data from the 10 sites as well as writing a paper that describes the results of this analysis. The results of the study show that service contracts for most SCs have demand charges and powerbands, which are components that could encourage demand-side management. There were some SCs with a time-of-use tariff, which is another contractual component that could encourage demand-side management. Demand response programs were also identified in a few sites, both market-based dynamic pricing and emergency response programs. The response by the SCs to these contractual components for demand-side management is limited due to SCs needing to utilize computational resource at full capacity in order to realize returns on infrastructure investment. That said, there are examples of SCs exhibiting strong interest in working closely with their ESPs to help maintain and improve electrical grid reliability, resiliency and efficiency.

ENERGY AND POWER AWARE JOB SCHEDULING AND RESOURCE MANAGEMENT:

Background: This team has kicked off in high-gear with both great participation as well as immediate work commencing on the initial goal of writing a whitepaper capturing the inventory of sites that are using energy and power aware job scheduling and resource management tools with large-scale implementations in a production and/or pre-production (technology development) environment.

News: Since we last met, the Team has completed interviews with 9 sites and has started to review and analyze the interview results. The sites include three in Japan (Riken, Tokyo Institute of Technology and the University of Tokyo), LRZ in Germany, CEA in France, CINECA in Italy, STFC in the United Kingdom, KAUST in Saudi Arabia and LANL in the United States. There are some similarities in motivation for all the Japanese sites- having to do with responding to emergency electricity grid situations like those that were posed by the 2011 tsunami. Otherwise, the motivation of the sites is more varied. Another clear trend is that all of the sites have used vendor supported software and not home-grown systems.

RFP CONSIDERATIONS:

Background: The EE HPC WG is maintaining a document that reflects ‘best practices’ for including energy efficiency as an important consideration when writing procurement documents for supercomputer acquisitions.

News: This is a team that has been relatively inactive for several years, but will be called back into action.

PARTICIPANTS INCLUDED

Name	Organization
Jeff Autor	HP
Natalie Bates	EE HPC WG
Anita Cocilova	LLNL
Chris DePrater	LLNL
Thomas Durbin	Independent
Parks Fields	LANL
Vladimir Getov	University of Westminster
David Grant	ORNL
Glen Hanna	Intel
Brandon Hong	LLNL

Sid Jana	Intel
Jim Laros	SNL
Detlef Labrenz	LRZ
Bill Lucnik	ANL
Ronald Luijten	IBM
Steve Martin	Cray Inc.
Dave Martinez	SNL
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Todor Milkov	SDSC
Ben Radhakrishnan	National University
Kim Schumann	Cray
Arsalan Shahid	University College Dublin
Tom Squillo	Environmental Systems Design, Inc.