Energy Efficient High Performance Computing Working Group
8/12/14 Meeting Report

INTRODUCTION

The EE HPC WG held a meeting on 8/12/14. 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, http://eehpcwg.lbl.gov.

NEXT MEETING: October 14th, 9:00-10:00AM Pacific Time

NEXT WEBINAR: September 25th, 9:00-10:00AM Pacific Time. John Shalf, David Donofrio, Alex Ramirez and Eric Van Hensbergen will present on Embedded Technologies for Supercomputers

Introductions and Announcements: ***Dale Sartor, LBNL***

- **Webinar: Embedded Technologies for Supercomputers**
  Thursday, September 25th 9AM PT
  John Shalf, LBNL
  David Donofrio, LBNL
  Alex Ramirez, Mt. Blanc Project at Barcelona Supercomputing Center
  Eric Van Hensbergen, ARM

Abstract: The increase in power of supercomputers has historically been achieved by increasing the number of conventional general-purpose microprocessors similar to those used in personal computers. Although this approach is feasible for building systems large enough to solve many current scientific problems, the approach becomes unsustainable when scaling this technology forward.
This BoF has a panel that explores novel new architectures and design techniques that present a radical alternative to conventional systems by borrowing many technologies and techniques from the cost and power sensitive design requirements found in the embedded world. These techniques frequently result in a more power-efficient design driving down the cost of operation and are overall cost-competitive with current approaches. System on Chip (SoC) is an example of such an embedded technology that will be the focus of this BoF. Participants are encouraged to bring experiences and insights in using embedded technologies for supercomputing.

- There is an extension of the Better Buildings Challenge for data centers that is open to anyone in the United States who is interested in improving their data center energy efficiency. https://www4.eere.energy.gov/challenge/partners/data-centers
- **EE HPC WG website is being renovated.** If you are interested in helping as a reviewer, please contact Natalie Bates.

Conferences Sub-group Update: ***Anna Maria Bailey & Marriann Silveira, LLNL***

- **News on EE HPC WG participation in upcoming Conferences**

- **SC'14**

The 5th Annual EE HPC WG workshop at SC14 will be all day Monday, November 17th.

Also, the EE HPC WG organized panel on "Challenges with Liquid Cooling – a Look into the Future of HPC Data Centers" is scheduled for Thursday, November 20th from 3:30 to 5:00.

We will have an exhibitor booth again this year, with thanks to OSIsoft for sponsoring it. It will be similar to the one we had last year with posters describing team activities and other team collateral. Please note, we are looking for volunteers to staff the booth. ***Please let Natalie know if you are willing to help with staffing the booth for a few hours.***

The Demand Response Team paper was rejected in the SC14 State of the Practice Tract, but has already been accepted at another conference that is more focused on the integration of IT and the electric Grid. This conference is Energy Informatics 2014
http://www.energieinformatik2014.org/?lang=en

There were 5 BoF submissions made this year and notifications will be sent September 8th. They are:

- Design, Commissioning and Controls for Liquid Cooling Infrastructure
- HPC System and Data Center Energy Efficiency Metrics and Workloads
- HPC Procurement Considerations for Energy Efficiency
- Dynamic Power Management for MW-sized Supercomputer Centers
- The Green500 List and its Continuing Evolution

- **ISC'14**

- ISC'14 was held in June in Leipzig, Germany and the EE HPC WG helped organize a panel and three Birds of Feather sessions.
- Axel Auweter from LRZ and Luigi Brochard from IBM presented a paper on "A Case Study on Energy Aware Scheduling on SuperMUC". That presentation was repeated as a webinar in July for the EE HPC WG.
- For our September webinar, John Shalf and David Donofrio from LBNL as well as Alex Ramirez, from the European Mont Blanc project will be repeating ISC BoF presentations that they made on "Embedded Technologies for Supercomputers". This is scheduled for September 25th at 9AM Pacific Time.
- Presentations from the other sessions are available as a link on the EE HPC WG website. http://eehpcwg.lbl.gov/sub-groups/conferences/isc-14/isc-14

Update on EE HPC WG participation in recent Conferences

- Dale Sartor spoke at the Data Center Dynamics Conference.
- Bill Tschudi made a presentation on the EE HPC WG at the ASHRAE TC9.9 meeting held in Seattle in late June.
- The EE HPC WG website lists many upcoming Conferences and Workshops that have an HPC Energy Efficiency Focus.

The EE HPC WG website Links and Events page lists many upcoming Conferences and Workshops that have an HPC Energy Efficiency Focus

Future Conferences: (more details at http://eehpcwg.lbl.gov/events-and-links)

Infrastructure Sub-Group Update: ***William Tschudi, LBNL & Dave Martinez, SNL***

EE HPC WG Liquid Cooling Technical Sessions at SC14:

As reported in the conferences update, we have a panel at SC14 on "Challenges with Liquid Cooling - a Look Into The Future of HPC Data Centers". This panel is scheduled for Thursday, November 20th from 3:30 to 5:00PM. The organizers are Torsten Wilde, Michael Patterson and Josip Loncaric.

> Abstract: Liquid cooling is key to dealing with the heat density, reducing energy consumption, and increasing the performance of this generation of supercomputers and becomes even more predominant on the roadmap for the foreseeable future. The transition to liquid cooling, however, comes with challenges.
>
> One challenge is that each system and each site comes with its specific issues regarding liquid cooling. These complicate procurements, design, installation, operations, and maintenance.
>
> This panel will review the immediate past history from a lessons learned perspective as well as discuss what's needed for liquid cooling to be implemented more readily in the future. This includes challenges such as data and metrics to assess the relative efficiencies of the different cooling technologies, water quality, heat recovery, the disparity between building life and cluster life, and other issues.
>
> How can we as a community address these challenges?

We also submitted a Birds of Feather session on "Design, Commissioning and Controls for Liquid Cooling Infrastructure". We won't know until September 8th whether or not this BoF will be accepted. The organizers for this BoF - Dave Martinez from SNL, Marriann Silveira from LLNL and Herbert Huber from LRZ. The intention for this BoF is to talk about the work we've done on liquid cooling inlet water temperature recommendations, commissioning and controls.

LIQUID COOLED COMMISSIONING TEAM UPDATE: The Liquid Cooling Commissioning Team has collected and reviewed best practices and lessons learned for commissioning of liquid cooling infrastructure. The ultimate goal is to improve the commissioning process for delivering a liquid cooling infrastructure that works when the HPC system is installed.

The Team has written a document that is intended to provide some general guidance and recommendations for those who are writing commissioning plans. The Team has 'lessons learned' from several supercomputer centers that help to illustrate the general guidance and recommendations.

CONTROLS TEAM: There are lessons learned and best practices evolving from implementing and operating supercomputer centers with complex infrastructure systems and the highly variable demands placed upon these systems with today's supercomputers. This team will focus on sharing designs, challenges and best practices for integrated control systems in order to determine if there are universal learnings.

The initial team output will be a short report documenting their findings and making recommendations for next steps.

The Team has been meeting regularly with strong participation. They have been sharing controls designs as well as issues and concerns. So far presentations have been made by LLNL, NCSA, ORNL and SNL and LANL. Argonne will present on Thursday, August 14th and LRZ is scheduled for Thursday, September 11th. The team meets from 9-10 AM Pacific Time.

TUE TEAM: This Team has developed two new metrics; iTUE and TUE [Total Power Usage Effectiveness (TUE) and IT Power Usage Effectiveness (ITUE)] that account for infrastructure elements that are a part of the HPC system (like cooling and power distribution). TUE is an improvement over PUE as a metric that allows for inter-site comparison. iTUE is not only a metric that is necessary for calculating TUE, but stands on its own as a metric for a site to use for improving infrastructure energy efficiency. The metric is being tested by several sites. For more information, see: https://www.brighttalk.com/webcast/679/96847

EE HPC WG Metrics and Workloads Birds of Feather at SC14:
Another of the Birds of Feather submissions touches upon TUE, but is a bit broader and covers both infrastructure and system metrics and workloads. Again, we'll know by September 8th whether or not the BoF is accepted.

ENERGY REUSE EFFECTIVENESS: The Energy Re-use Effectiveness Team in collaboration with The Green Grid has developed a standard metric for measuring the contribution of re-using heat generated by HPC systems for other useful purposes. There is no new information to report on this activity. Anyone interested in sharing your experiences or testing the ERE metric should contact Natalie.

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

SYSTEM WORKLOAD POWER MEASUREMENT METHODOLOGY: The EE HPC WG along with the Green500, Top500 and Green Grid have developed a standard methodology for measuring system power while running a workload. The team developed the methodology, refined it through both alpha and beta testing and collaborated with the Green500 List to ensure adoption as an enhancement to the Green500 run rules. The team is now developing outreach and other tools for broader adoption of the measurement methodology. The ultimate goal is to have broad use of the highest quality energy and power measurement methodology for all of their system workload energy efficiency benchmarking activities.

The team is now focused on doing an analysis that quantifies the variation in measurement results between a L1, L2 and L3 measurement. Our hypothesis is that L1 and L2 variation is greater than L3. We are collecting data in three areas: variation in node power affecting sample size, contribution of the interconnect, differences in power draw during the core run. The intent of this analysis is to recommend changes to the L1 requirements; increasing the quality and stringency of the requirements.

There was one L3 submission to the June'14 Little Green500 List.

The India Center for the Development of Advanced Computing made a L3 submission in November'13. They have reported on their experiences to the team and may repeat the presentation as a webinar for the EE HPC WG.

HPC AND GRID INTEGRATION: The Demand Response Team is investigating how HPC centers have, can and should engage more actively with the Grid electricity providers. This is an investigative activity with the ultimate goal of educating the HPC DOE Facility and Operations Managers about HPC and grid integration opportunities and challenges.

The Team has collected information from 11 US-based SC sites that are on the Top100 list. This includes LLNL, LANL, ORNL, LBNL, ANL, Purdue, SDSC, NCSA, NOAA, Intel and WPAFB. The results of this analysis have been captured in a paper that will be presented at a conference called "Energy Informatics" in mid-November in Zurich.

> Germany, Austria, and Switzerland have committed themselves to ambitious energy efficiency and emission reduction targets. The field of Energy Informatics (EI) strives for developing the IT based solutions that are required to attain these goals. The emerging Smart Grid infrastructures and their applications to better integrate renewable energy sources, to improve demand side management, and to increase overall efficiency, dependability, and security of supply form a cornerstone of the development.
> The goal of the EI conference is to support the research driven development and deployment phase of related information and communication technology (ICT) and to facilitate the interplay between scholars and practitioners. It is directed at both, research institutions and companies in an attempt to intensify the cooperation within Germany, Austria, and Switzerland.

The team is now focused on extending this work to European-based SC sites that are on the Top50 list. We have received feedback on a modified questionnaire from CEA, LRZ, Julich and HLRS.

PROCUREMENT CONSIDERATIONS: The RFP Team has a whitepaper that recommends procurement document requirements that target more energy efficient HPC systems. The intention is to raise the bar and extend the requirements with a yearly update of the whitepaper. The 2013 focus is on measurement capabilities.

The Team has been honing the measurement capability requirements based on feedback from the vendor webinars as well as input at SC13. This process is complete and the final document is posted on the EE HPC WG website.

The Team has started to work on the 2014 update. We have a draft statement of 'time-stamping' requirements and have started to work on 'measurement uncertainty' as well as temperature sensors and measurements.

SW UPDATE

A solicitation to the EE HPC WG requested proposals for software teams. There were six respondents who made very thoughtful proposals. Some of the common themes are benchmarks, APIs, tools. We are meeting as a small team to review proposals, find synergies and discuss next steps. No news to report.

PARTICIPANTS INCLUDED

Name	Organization
Anna Maria Bailey	LLNL
Natalie Bates	EE HPC WG
Hsu Chung-Hsing	ORNL
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Matt Kappel	Cray
Kevin Kucera	RPM Electric
Rodney Martin	NASA
Dave Martinez	SNL
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