

WORKSHOP ON ENERGY EFFICIENCY

Michael Ott, Leibniz Supercomputing Centre 30/05/2018, Ljubljana

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AGENDA

14:30	Welcome & Report on EE HPC WG	Michael Ott, LRZ
14:50	100% Warm-water Cooling with CoolMUC-3	Axel Auweter, Megware
15:15	The Mont-Blanc 3 Project	Etienne Walter, Atos
15:40	Coffee Break	
16:00	The Global Extensible Open Power Manager - GeoPM	Matthias Maiterth, LMU&Intel
16:25	MULTITHERMAN: Out-of-band High-Resolution Power and Performance Monitoring Support for Big-Data Analysis	Antonio Libri, ETH
16:50	Q&A and Wrap-Up	

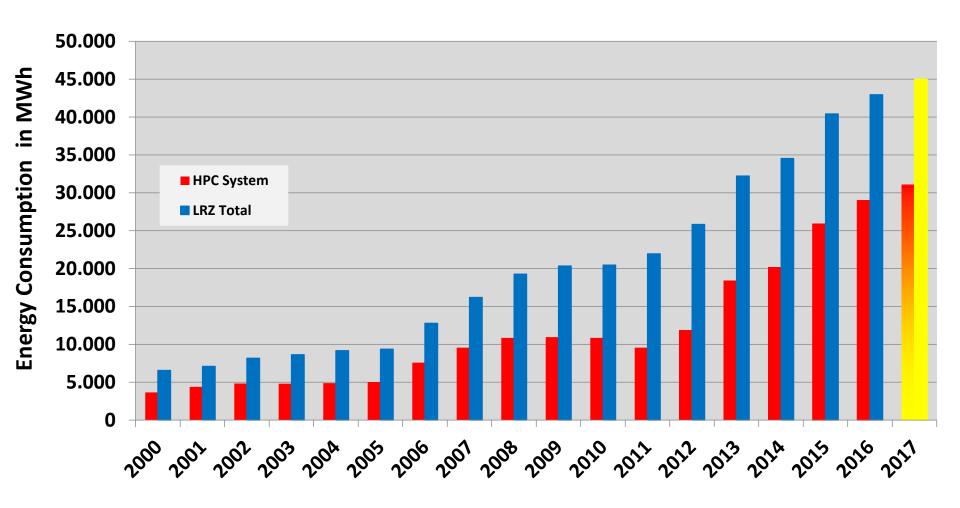


ENERGY EFFICIENCY IN HPC

- Moore's law is coming to an end
- Supercomputers are not becoming faster anymore, just wider
- Power envelope is increasing:
 - -#1 Top500 11/2007: 2.3 MW
 - -#1 Top500 11/2012: 8.2 MW
 - -#1 Top500 11/2017: 15.4 MW
 - First Exascale systems will be ~30MW
- Every % increase in efficiency counts!



ENERGY CONSUMPTION AT LRZ





THE FOUR PILLAR MODEL

Neighboring Buildings

> Utility Providers

Goal Goal Goal Goal Improve PUE Reduce **Optimize Optimize** Hardware Power Resource Usage, (Power Usage **Application Tune System** Performance Effectiveness) Consumption Global Optimization Strategy **Building HPC System HPC System HPC Infrastructures** Hardware **Software Applications Data Center** (Goal: Reduce Total Cost of Operation)



THE FOUR PILLAR MODEL

Neighboring Buildings

Utility Providers

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- Reduce power losses in power supply chain
- Exploit possibilities for using compressor-less cooling and use energy-efficient cooling tech (e.g. direct liquid cooling)
- Re-use waste heat of IT systems

Building Infrastructures

- Use newest semiconductor technology
- Use energy saving processor and memory technologies
- Consider using special hardware or accelerators tailored for solving specific scientific problems or numerical algorithms

HPC System Hardware

- Monitor energy consumption of compute systems and cooling infrastructure
- Use energy aware system software to exploit energy saving features of target platform
- Monitor and optimize performance of scientific applications

HPC System Software

- Use most efficient algorithms
- Use best libraries
- Use most efficient programming paradigm

HPC Applications

Data Center (Goal: Reduce Total Cost of Operation)



ENERGY EFFICIENCY AT LRZ

- Pioneer in direct-liquid hot-water cooling
- Heat re-use (heating, adsorption chillers)
- Energy-aware scheduling
- Broad instrumentation of all infrastructure
- DCDB: High frequency, high resolution monitoring and analysis



PIONEER IN HOT WATER COOLING

2011

CoolMUC-1

Megware 178 nodes

2015

CoolMUC-2

Lenovo 384 nodes, 466 TFlop/s 2017

CoolMUC-3

Megware 148 nodes, 394 TFlop/s

2012

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SuperMUC Phase 1

IBM

9216 nodes, 3.2 PFlop/s

2015

SuperMUC Phase 2

Lenovo

3072 nodes, 3.6 PFlop/s

2018

SuperMUC-NG Phase 1

Intel/Lenovo

6480 nodes, 26.9 PFop/s



ETP4HPC WORKING GROUP ON ENERGY EFFICIENCY

Why

- Many ETP4HPC members are active in the field of energy efficiency
- Energy efficiency is a very European topic
- Focus in Europe is different than in the US and EE HPC WG
- What
 - Bringing together like minded people
 - Fostering a pan-European network for collaboration
 - Sharing experience and lessons learned
- How
 - Workshops
 - Mailing list
 - Teleconferences



EE HPC WG: IN A NUTSHELL

Mobilize community to accelerate energy efficient HPC

- Explore innovative approaches
- Peer to peer exchange
- Share best practices
- Take collective action

http://eehpcwg.llnl.gov

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EE HPC WG

~700

Members

25+ countries

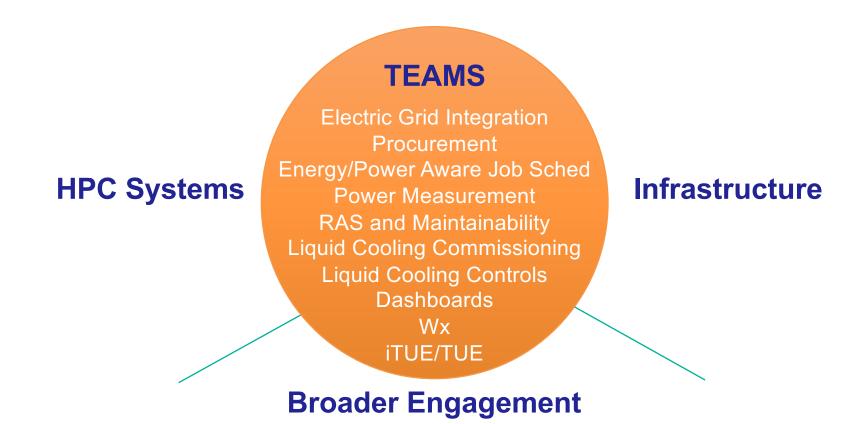
50% GOV

30% COM

20% EDU



EE HPC WG: INTER-DISCIPLINARY BLEND





EE HPC WG: INFRASTRUCTURE

- Controls
- Energy Reuse Effectiveness
- High Voltage Direct Current
- Liquid Cooling (Wx)
- Liquid Cooling Commissioning
- Maintainability
- TUE and iTUE



EE HPC WG: HPC SYSTEMS

- Energy and Power Aware Job Scheduling and Resource Management
- HPC and Grid Integration
- Procurement Considerations Documents
- System Workload Power Measure Methodology



EE HPC WG: BROADER ENGAGEMENT

- Conferences
- Workshops
- Papers
- Website
- Webinars

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Press



EWHPC

European Workshops on HPC Infrastructures









EE HPC WG @ ISC18

- 24/06 09:00 Tutorial: Boosting Power Efficiency of HPC Applications with GEOPM
- 25/06 13:00 BoF: Preparing to Liquid Cool Your Next HPC Deployment
- 25/06 16:00 Focus session: What's new with Cloud Computing for HPC
- 25/06 17:30 Award-winning paper: On the Accuracy and Usefulness of Analytic Energy Models for Contemporary Multicore Processors
- 26/06 09:30 BoF: The Green500: Trends in Energy Efficient Supercomputing
- 26/06 10:30 BoF: Energy and Power Aware: Job Scheduling and Resource Management
- 27/07 14:45 Special event: An Analysis of Contracts and Relationships between Supercomputing Centers and Electricity Service Providers
- 28/06 14:00 Workshop: Energy Efficiency Tools for High Performance Computing EETHPC

