

# 4<sup>th</sup> DOE Workshop on HPC Best Practices:

## Power Management

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San Francisco

Leveraging and encouraging  
power and cooling innovations in  
the commodity ecosystem

# Breakout Participants

- Mark Seager (Lead)
- Buddy Bland (Co-Lead)
- Bryan Biegel
- Jeff Broughton
- Dave Cowley
- Pam Hamilton (Note taker)
- Ken'ichi Itakura
- Anthony Kenisky
- Patricia Kovatch
- John Lee
- Tim McCann
- Tommy Minyard
- Bill Tschudi
- Ash Vadgama

# Our Mission:

- Review current trends in power/cooling innovations in the commodity ecosystem
- Discuss the impacts to DOE HPC facilities planning

# Experience: Novel/Interesting Approaches

- Seager – Free air cooling; 85% of the year LLNL can utilize free air cooling; For a \$.4.5M modification, can add free air cooling to TSF and drop PUE to 1.15 from 1.34; this is a very different direction from the modular/container trend. Containers are VERY expensive (upwards of \$500k for site prep).
- Tschudi – DC power to the rack and in rack; plug renewables in easier; higher reliability; unique opportunity to standarize globally on 380V
- Minyard - Immersed cooling (mineral oil); can overclock processors; must seal drives; don't need a raised floor

# Experience: Novel/Interesting Approaches (cont)

- Tschudi - Remove fans replace with conductive ribbon (Clustered Systems); server manufacturers would have to adapt
- Moving away from raised floors
- Minimizing layers of fans down to one layer

# Best Practices

- Ask industry through the RFP process
  - Improved power efficiency
  - HPC wide standards or guidelines
- Raise temp of inlet air and water to facility
  - Get to upper end of ASHRAE range (80F/27C)
  - May have to put equipment which requires a different range in a different room
- Reuse of heat
- Free cooling (air and water)
- Liquid cooling (rack or even down to the chip)

# Best Practices (cont)

- Separate hot and cold air
- Rack or higher level engineering to increase/improve power and cooling efficiency
- High voltage power distribution
  - Minimize  $I \cdot R$  drop
  - Minimize cost of cables

# Gaps Looking Forward to New Systems

- Appro – It would be better if HPC facilities banded together to push for standards and not have each lab come up with their own requirements.
- Seager – be careful with standards because they can restrict innovation.



# Gaps Looking Forward to New Systems (cont)

- Tschudi – Maybe we should be thinking about broader guidelines rather than deciding a winner between say liquid cooling vs. containers.
- Raising the ASHRAE the temp limits

# Gaps Looking Forward to New Systems (cont)

- HPC centers need to figure out how to leverage rack and higher level designs coming out of large data center deployments
- HPC and large data centers are on different trajectories
  - Water (HPC) vs. Air (IT)
  - Modular (IT) vs. Consolidated facilities (HPC)

# Evolve or start over for future systems

- Free air cooling
- Within the limitations of your facility you can evolve but a new facility or a major renovation is required for disruptive changes

# Issues shared with large commercial centers

- Multi-MW data centers
- High power density configurations
  - 1800 to 2500 watts per sq foot
- Very heavy floor loading
- Current cost of power plus uncertainty of future cost of power
- Use same component technology
- Security (cyber and physical)
- Capital, operating and facility budgets are often separated leading to miscalculations of TCO benefits

# Hardware/facility/system interfaces to influence

- Broaden humidity tolerances
- Raising the ASHRAE the temp limits

# How do we incentivise industry?

- Develop an R & D agenda for power and cooling improved efficiencies
- Big budgets garner attention
- Subsidize the R & D and collaborate on design/demonstrations
- Align procurements with R & D