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And others on the Compute System Metrics Team

SETTING TRENDS FOR ENERGY-EFFICIENT SUPERCOMPUTING

ISC BoF; June 2011; Hamburg, Germany

WHY WE ARE HERE

- Context
  - Power consumption and facility costs of HPC are increasing.
- "Can only improve what you can measure"
- What is needed?
  - Converge on a common basis for:
    - METHODOLOGIES
    - WORKLOADS
    - METRICS

    for energy-efficient supercomputing, so we can make progress towards solutions.

AGREEMENT IN PRINCIPAL

- Collaboration between Top500, Green500, Green Grid and EE HPC WG
- Evaluate and improve methodology, metrics, and drive towards convergence on workloads
- Report progress at SC and ISC

COMPLIMENTARY METRICS

× "Data Center" Measurements
+ Power Usage Effectiveness (PUE)
  × PUE = Total Facility Energy/ IT Energy
+ Energy Reuse Effectiveness (ERE)
  × ERE = (Total E.-Reused E.)/IT Energy

AND

Today's focus

× "Compute System" Measurements
+ Workload/Productivity Metrics
+ Useful Work / Energy Consumed

PROPOSED METRIC GRANULARITY

- Measure behavior of key system components including compute, memory, interconnect fabric, storage and external I/O
  - Workloads and Metrics might address several components at the same time
- Phased implementation planned

PROPOSED WORKLOADS

- *Leverage well-established benchmarks*
- *Must exercise the HPC system to the fullest capability possible*

- Use High Performance LINPACK (HPL) for exercising (mostly) compute sub-system
- Use RandomAccess (Giga Updates Per second or GUPs) for exercising memory sub-system (?)
- *Need to identify workloads for exercising other sub-systems*
  - *e.g.: SNIA has a Green Storage Initiative*

UNIFY AND IMPROVE METHODOLOGY

- HPL and RandomAccess measurement methodologies are well established
- Green500 & TOP500 power-measurement methodology
  - Similar, but not identical methodologies
- Issues/concerns with power-measurement methodology
  - What to include in the measurement (e.g., integrated cooling)
  - Node, rack or system level measurements
  - Variation in start/stop times as well as sampling rates
  - Need to increase vendor and/or supercomputing center power-measurement reporting
    - November 2010 Green500 List – 54% of the list were submitted /measured numbers, the other 46% were derived by Green500

UNIFY AND IMPROVE METHODOLOGY

- Current power measurement methodology is very flexible, but compromises consistency between submissions
- Proposal is to keep flexibility, but keep track of rules used and quality of power measurement
- Tiers of power measurement quality
  - Sampling rate; more measurements means higher quality
  - Completeness of what is being measured; more of the system translates to higher quality
  - Common rules for start/stop times

PROGRESS SINCE SC BOF

- Focus on improving power measurement methodology
  + Survey key sites to clarify issues and concerns
  + Proposal for tiers of power measurement quality
- Working paper drafted and under review
- Team broadened to include representatives from major sites and additional industry players
- MOU between The Green Grid, the Top500, the Green500 and the EE HPC WG

ISSUES TO RESOLVE

- *Identify workloads for exercising other sub-systems; e.g., storage, I/O*
- *Still need to decide upon exact metric*
  - *Classes of systems (e.g., Top50, Little500)*
  - *Multiple metrics or a single index*
- *Implement tiers of power measurement quality*
- *Facilitate increased vendor and/or SC center power measurement reporting*
- *Include idle as well as fully exercised measurements*

WHY WE ARE HERE

- To gather community momentum and support
- To solicit your feedback
- To ask you to participate by submitting power measurements for Top500 and Green500 Lists

Energy Efficient HPC Working Group
EE HPC WG

- Driving energy conservation measures and energy efficient design in high performance computing.

- Demonstrate leadership in energy efficiency as in computing performance.

- Forum for sharing of information (peer-to-peer exchange) and collective action.

http://eehpcwg.lbl.gov

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EXTRA SLIDES

STAKEHOLDERS AND PURPOSE?

- Stakeholders
  + *HPC computer system designers and procurement decision makers*, including users, data center and facilities designers/managers

- Purpose
  + *Unite the community behind energy efficiency metric(s) for HPC systems* that form the basis for comparing and evaluating individual systems, product lines, architectures and vendors

WHAT IS A METRIC?

- A basis for comparison
- A reference point against which other things can be evaluated
- A measure

WHAT MAKES A METRIC EFFECTIVE ?

× Granular enough

+ Individual components

+ Analyzed in manageable chunks

+ Assigned to specific parties for improvement

× Intuitive, obvious, and clear

× Scientifically accurate and used precisely

× Sufficiently flexible to respond to new technology developments

× Vendor-neutral

× Inexpensive and worthwhile

Stanley, J.R., Brill, K.G. and Koomey, J. "Four Metrics Define Data Center 'Greenness,'" Uptime Institute White Paper http://www.verneglobal.com/pdf/WP_FourMetrics.pdf

WHAT IS A WORKLOAD?

✖ The application or benchmark software designed to exercise the HPC system to the fullest capability possible

AGREEMENT TO USE WORKLOAD METRICS

- ✖ Use Workload-based Metrics to Represent HPC Energy Efficiency
- ✚ Use workload-based for numerator and measured power during workload run for denominator
- ✖ Examples
- ✚ Green500 "FLOPS per Watt"
- ✚ SPEC FP / Measured Watt
- ✚ Green Grid "Productivity Proxies"

- ✖ *Still need to decide upon exact metric*
- ✚ *Classes of systems (e.g., Top50, Little500)*
- ✚ *Multiple metrics or a single index*
- ✖ *Idle as well as full stress*

WHAT IS A METHODOLOGY?

- The system of methods followed

- A way of doing something, especially a systematic way; implies an orderly logical arrangement (usually in steps)

- A measurement procedure

THE GREEN GRID BOARD MEMBERS