International PostExascale

Workshop Series

InPEx pre-workshop - 19-20 October 2023

Thematic subgroup on
Energy, environmental impact and sustainability.
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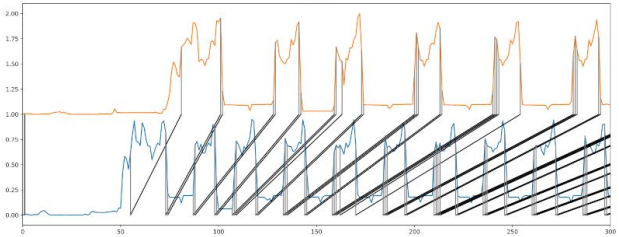
Energy, environmental impact and sustainability.

Context:
Several levels: Hardware (including datacentre); Applications; Middleware.
Available leverages:

- Conventional: Improve hardware, software, compilers, numerical libraries, scheduling, dynamism (tasks-based applications)
- Unconventional: reconfiguration of applications, of hardware; power capping, approximate computing; cross-system scheduling

New constraints: curtailment; CO2 and energy reporting and budget.

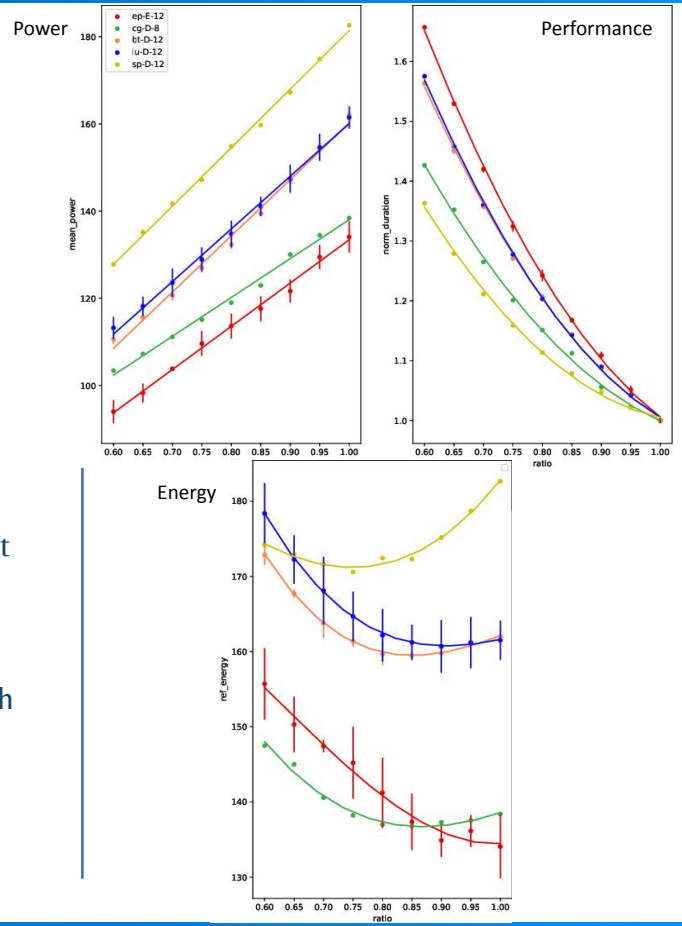


Problematic(s):

- Power and Energy reduction
- CO2 impact
- Cost for users
  - At the cost of performance?
  - At the cost of usability / portability / code sustainability?
- Education: even fundamental understanding is lacking

Challenges:

- Scientific
  - Power, energy and performance models of the system, of the impact of leverages
  - Scaling: monitoring data; number of possible decisions.
  - Heterogeneity: applications are unique; homogeneous hardware is heterogeneous.
  - Decision level: Operating system? Application? Platform? All of the above?
  - User involvement and acceptance.
  - Datasets such as classical benchmarks power profiles
  - Eco-design of software, libraries
- Technical
  - Real-time measurements (wattmeters, RAPL, ...) with low impact, sufficient accuracy and an open API
  - Link with Supercomputer operators (including security)
- Contextual
  - Demand/response, flexibility and integration in the electrical grid along with its dynamic carbon footprint
  - Model of reachable gains
  - Involvement of users (with gains if eco-responsible)
  - Metrics, beyond PUE and Green500



Open discussion on Energy, environmental impact and sustainability:
Multiple point of views: Operators; Users; Theoretical researchers

Must be addressed even before installation. It depends on several factors

- Location; Annual temperature & climate; Water access; Heat reuse.

Operator point of view: The goal is to produce a maximum of science. Only external political decision can lead to reduction of this objective. In some cases, political bodies can request to reduce the energy or power consumption due to problem on the overall grid. The impact already comes from the construction of the platform, so it is better to use it at maximum capacity.

Research in Energy-Efficiency of HPC : Capabilities of moving around peak power (using heterogeneity of applications)

Operational cost can be a limitation. The operators must maximize the scientific output under the budget constraint. In some cases,

How can we give useful feedback to users whether they are using a system efficiently? (already a question for performance)

- Look for performance/power draw outliers? For example can occur for storage.
- Need for better metrics, both to assess efficiency overall and to better communicate to users. Might need automated feedback to lessen the human pressure.
- Might use alternative allocation than core-hours such as overall Joules.

Common ecosystem across regional systems to load balance workload?

Hierarchy of measures that have different levels of impact, from electricity generation, and data centre down to system configuration and applications/libraries.

Conclusions:

Must be driven by political entities: Priority is science, and the goal is to optimize CO2 per Nobel Prize

Actions:

- [Tool] Providing feedback to users: Eq. CO2, Wh, up to abnormal behavior for certain libraries
- [Workshop] Discussion on metrics: how to improve Green500, PUE
- [Workshop] Session on success stories and actual failures of pre-exascale operators
- [Workshop] Challenge for students/researchers: Use actual application on a datacenter to reduce power consumption while keeping the same performance
- [Lobbying] Clarify the political expectation and their societal impact
- [Workshop] Processor technologies - e.g. reducing standby power consumption
- [MOOC] User education