Energy-agility: A New Grid-centric Metric for Evaluating System Performance

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Rethinking Energy-efficiency (1/4)

Energy-efficiency = Work done per joule of energy used

- Better energy-efficiency → systems run longer
- Better energy-efficiency → lower energy bills, lower carbon footprint
Rethinking Energy-efficiency (2/4)

What is wrong with the datacenter scenario?

*Misplaced Assumptions!*

- All energy is created equal
- Energy is available at any time
Rethinking Energy-efficiency (3/4)

Why energy-efficiency is not sufficient?

<table>
<thead>
<tr>
<th>Energy Consumed</th>
<th>Less</th>
<th>More</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish Time</td>
<td>Later</td>
<td>Earlier</td>
</tr>
</tbody>
</table>
How do we evaluate green compute systems?

<table>
<thead>
<tr>
<th>Energy-efficiency</th>
<th>✗ Solely driven by workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy-proportionality</td>
<td>✗ Opaque to energy characteristics</td>
</tr>
<tr>
<td>Energy price</td>
<td>✗ Non-standard metric</td>
</tr>
</tbody>
</table>
Energy-agility (1/3)

**Energy-efficiency** = Work done per joule of energy *consumed* by the system

**Energy-agility** = Work done per joule of energy *available* to the system

Formally,

Energy-agility = Work done given a power signal $P(t)$ that dictates an energy cap over each interval $(t - T, t]$
Energy-agility (2/3)

Salient Characteristics

1. Accounts for energy **used** and **wasted**

2. Captures energy characteristics

3. Quantifies dynamics between a **platform**, its **workload** and its **energy**

   - Enables a rigorous and Price-independent system evaluation
Energy-agility (3/3)

Design Considerations

**System**
- Input power signal
- Energy Storage
- Platform power states

**Application**
- Inter-node coordination vs. Intermittent power changes
Conclusion

Energy-efficient systems are not necessarily “green”

- Quality/characteristics of energy matter as much as the quantity
- Current metrics are ineffective for green energy

We propose a new metric, **energy-agility**

- Enables a rigorous performance evaluation of a green compute system
Questions

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Thank you!