

Dynamic Power Management for Megawatt-Sized Supercomputer Centers

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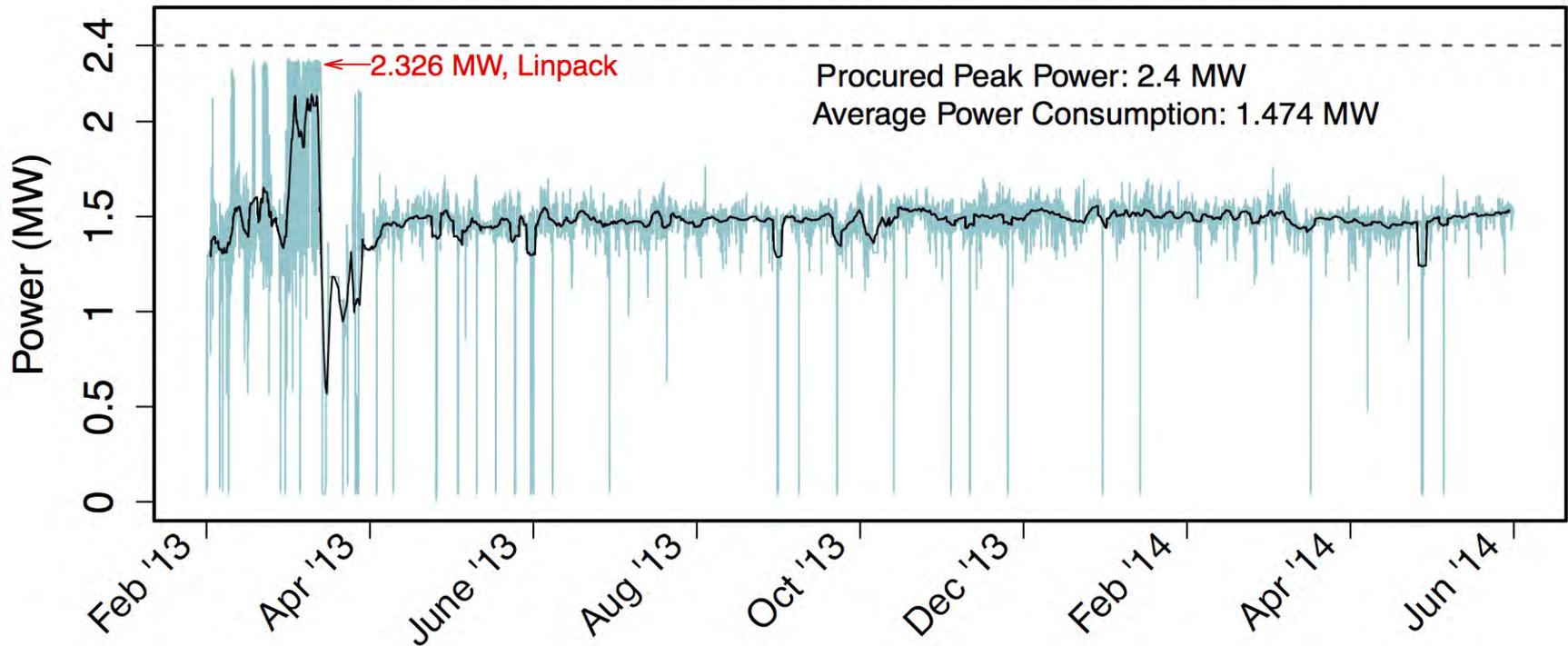
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Unused Power

**Total Power Consumption of the BG/Q Vulcan Supercomputer
Feb 2013 to Jun 2014 (3 minute time samples)**



Problem

20

Megawatts

0

↕ 5% Desirable range

Problem is **power utilization**,
not power procurement

Don't:

- “Save” Power
(or, Energy)

Do:

- Use power to do
more science
- Improve application
performance

100%

Power Utilization

0%

Solution: HW Overprovisioning

20

Megawatts

0

↕ 5% Desirable range

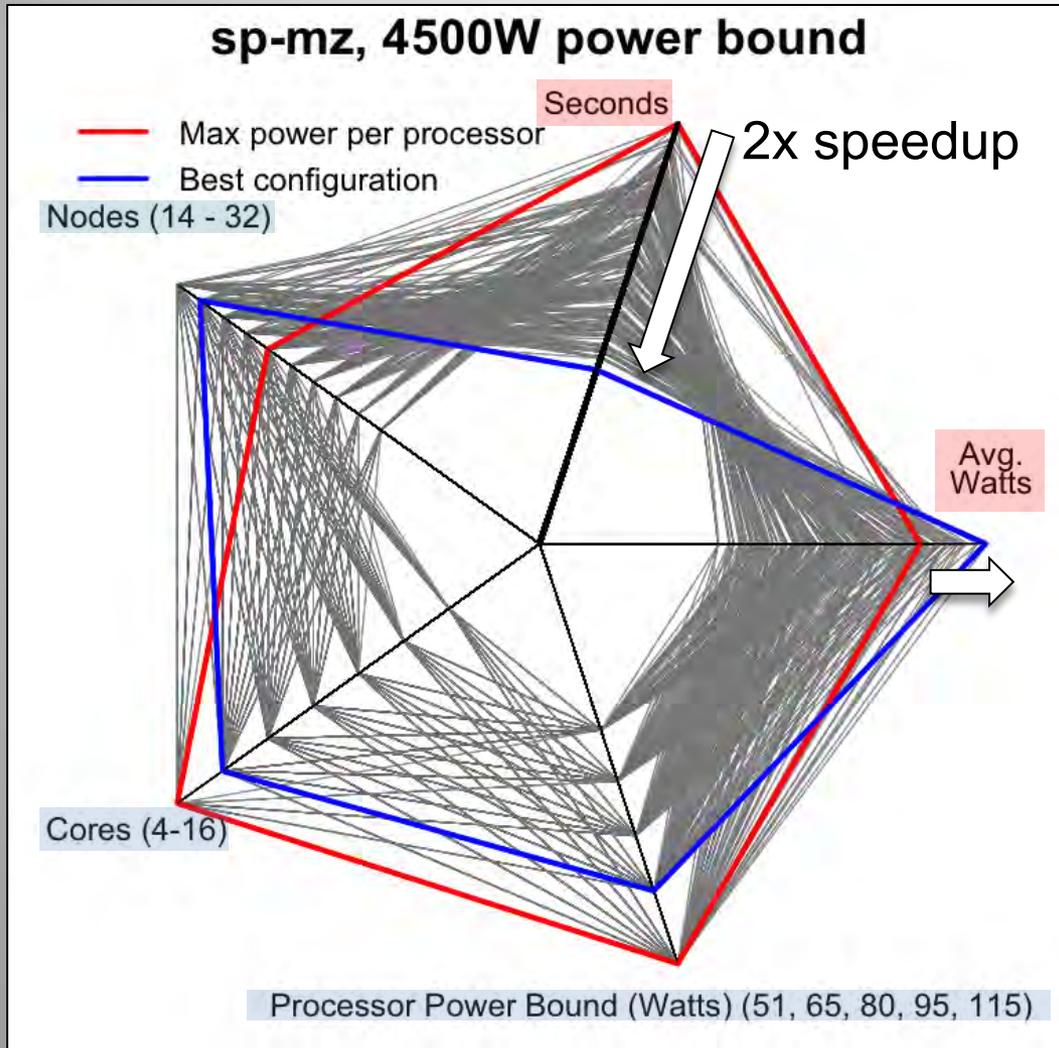
- Rethink utilization in terms of power, not nodes
- Not all nodes can run at peak power simultaneously
- Reconfigure dynamically based on workload characteristics to improve performance

100%

Power Utilization

0%

Improving Performance



CFD solver kernel

Traditional configuration

Poor performance,
doesn't use allocated
power

Best configuration

2x improvement in
performance, uses all of
the allocated power

Improving Performance

Choose the **right configuration** under a power bound based on **application characteristics**

- Scalability:
 - Fewer nodes, higher power per node
 - More nodes, lower power per node
- Memory intensity:
 - Vary cores per node

Dynamic Power Management

Site

- Demand Response, Renewables

Cluster

- Overprovisioning, Job scheduling

Job/Application

- Adaptive runtimes, Power balancing

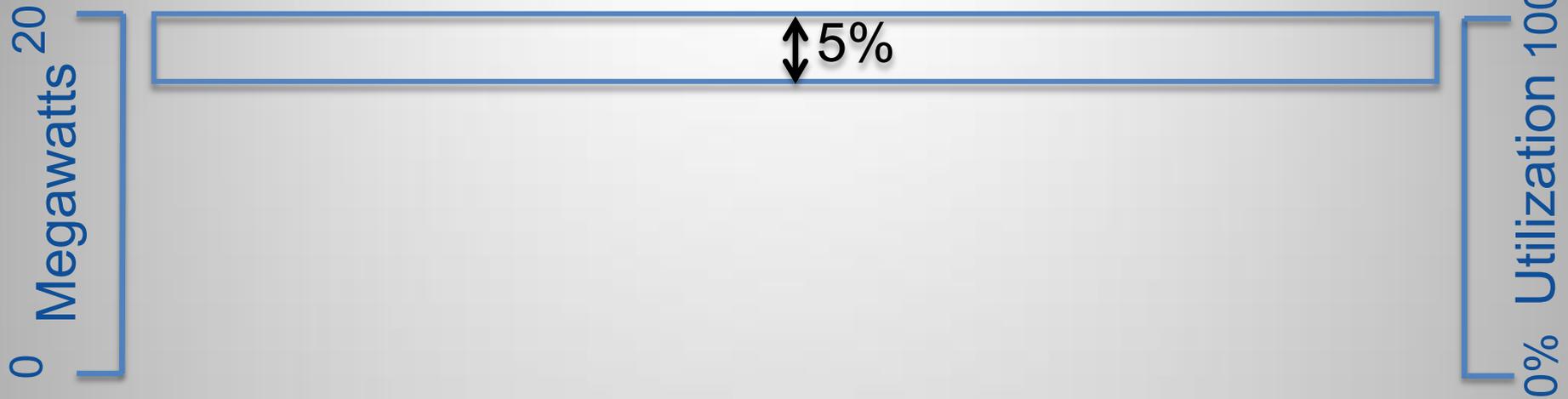
Node

- Measurement & control, Power capping

Inherited Power Bounds

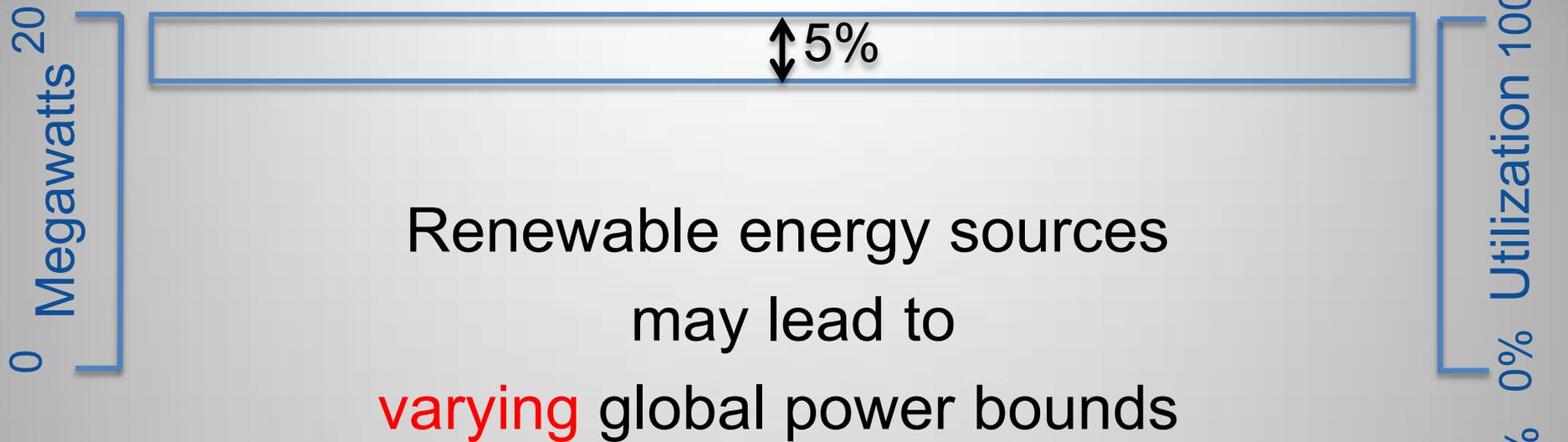


Static global power bound



Renewable energy sources
may lead to
varying global power bounds...

Static global power bound



Thanks

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