NapSAC: Designing a power proportional web cluster

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Outline

• Recap of power proportional computing

• Related Literature

• NapSAC Architecture

• Results

• Conclusion
Case for power proportional computing

25 X
PUE = \frac{\text{Total Power Used}}{\text{IT Power}}

PUE typically around 1.4

Should getting this to 1 be our goal?
Low Cluster Utilization

Power proportional computing

Over-provisioning or Spinning Reserve

Dynamic Capacity Management

Static Load Provisioning

Dynamic Load Arrival

Time
Workload Breakdown

PC Energy Usage

Enterprise Desktops
- Somniloquy (NSDI 09), LiteGreen (NSDI 10), SleepServer (NSDI 10)

Home Machines
- Voltage and Frequency Scaling (DVFS), OS power managers

Server Rooms
- Batch Workloads
- Interactive Workloads
- VM Consolidation
- NapSAC
NapSAC Architecture

Load Balancer

Server Machines

Backend DB

Request

Response
NapSAC Architecture

Load Balancer

Server Machines

Sleeping

Active

Over-utilized

Backend DB

Request → Load Balancer → Server Machines → Backend DB

Response ← Load Balancer ← Server Machines ← Backend DB
NapSAC Architecture

Load Balancer

Server Machines

- Sleeping
- Active
- Over-utilized

Backend DB

Request

Response
Energy–efficiency and Response Times of a Nehalem Node

- Joules/Response
- Response Time

Operating Range
Node Efficiencies

Energy–efficiency and Response Times of an Atom Node

Requests/sec

Joules/Response

Response Time (sec)

Operating Range
Node Efficiencies

Energy–efficiency and Response Times of a Beagle Embedded Node

Requests/sec

Joules/Response

Response Time (sec)

Operating Range
### Node Efficiencies

<table>
<thead>
<tr>
<th>Node Type</th>
<th>Efficiency (J/req)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nehalem</td>
<td>0.75 – 2</td>
</tr>
<tr>
<td>Atom</td>
<td>1 – 2</td>
</tr>
<tr>
<td>Beagle</td>
<td>1 – 3</td>
</tr>
</tbody>
</table>
LoCal Cluster

16 Atom Backend Nodes

4 Nehalem Backend Nodes

Load Balancer Node

16 BeagleBoard Backend Node
NapSAC Architecture

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Request

Response
Wikipedia Load

- Real Load
- Dynamic Capacity
- Static Capacity

Requests per second

Efficiency (Requests per Joule)
Need for Heterogeneity
Summary

• Different architectures show different efficiencies
• Heterogeneity introduces sleep capabilities
• Server class machines handle base load – Mobile class agile nodes handle spikes
• Setting cluster utilization set point within operating range is crucial
• 70% energy savings compared to baseline and 90% energy savings compared to optimal
Backup Slides
NapSAC Provisioning Manager

TODO:
Make lines come in one by one