Debunking some Common Misconceptions of Science in the Cloud

Shane Canon
Lawrence Berkeley National Lab

ScienceCloud 2011
San Jose, CA
The Push towards Clouds

A survey of 102 large, multinational companies across the world found that nearly half (45 percent on average) have adopted some sort of third-party-hosted cloud service this year (28 percent last year). --Ovum (May 2011)

To harness the benefits of cloud computing, we have instituted a Cloud First policy. This policy is intended to accelerate the pace at which the government will realize the value of cloud computing by requiring agencies to evaluate safe, secure cloud computing options before making any new investments.
The Hype around Clouds

Gartner’s 2010 Emerging Technologies Hype Cycle

This talk will try to shove us down the hill
Cloud Misconceptions

• Clouds are simple to use and don’t require system administrators.
• My job will run immediately in the cloud.
• Clouds are more efficient.
• Clouds allow you to ride Moore’s Law without additional investment.
• Commercial Clouds are much cheaper than operating your own system.
Are Clouds Easy to Use?

From Experience with Magellan we have Learned

• IaaS Clouds can require significant amounts of system administration expertise
• Images must be customized for the application
• No batch environment. No global file system.
• Users must properly secure and protect their images and instances.
• Do we want to turn scientists into system administrators?
Cloud Misconceptions

- Clouds are simple to use and don’t require system administrators.
- My job will run immediately in the cloud.
- Clouds are more efficient.
- Clouds allow you to ride Moore’s Law without additional investment.
- Commercial Clouds are much cheaper than operating your own system.
Is the Cloud Elastic enough for HPC?

Peak Cores Required for Franklin (38,340 cores)

Number of cores required to run a job immediately upon submission to Franklin
Cloud Misconceptions

• Clouds are simple to use and don’t require system administrators.
• My job will run immediately in the cloud.
• **Clouds are more efficient.**
• Clouds allow you to *ride* Moore’s Law without additional investment.
• Commercial Clouds are much cheaper than operating your own system.
Application Performance
Application Benchmarks

Runtime relative to Carver

- Carver
- Franklin
- Lawrencium
- Amazon CC
- Amazon EC2

MILC
PARATEC
Application Scaling

PARATEC

MILC

Performance relative to native (IB)

Number of cores

Performance relative to native (IB)

Number of cores
Assumptions for cost saving from Clouds aren’t true for HPC Centers.

<table>
<thead>
<tr>
<th>EFFICIENCY</th>
<th>Cloud Benefits</th>
<th>Current Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improved asset utilization (server utilization &gt; 60-70%)</td>
<td>Low asset utilization (server utilization &lt; 30% typical)</td>
</tr>
<tr>
<td></td>
<td>Aggregated demand and accelerated system consolidation (e.g., Federal Data Center Consolidation Initiative)</td>
<td>Fragmented demand and duplicative systems</td>
</tr>
<tr>
<td></td>
<td>Improved productivity in application development, application management, network, and end-user</td>
<td>Difficult-to-manage systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGILITY</th>
<th>Cloud Benefits</th>
<th>Current Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Purchase “as-a-service” from trusted cloud providers</td>
<td>Years required to build data centers for new services</td>
</tr>
<tr>
<td></td>
<td>Near-instantaneous increases and reductions in capacity</td>
<td>Months required to increase capacity of existing services</td>
</tr>
<tr>
<td></td>
<td>More responsive to urgent agency needs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INNOVATION</th>
<th>Cloud Benefits</th>
<th>Current Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shift focus from asset ownership to service management</td>
<td>Burdened by asset management</td>
</tr>
<tr>
<td></td>
<td>Tap into private sector innovation</td>
<td>De-coupled from private sector innovation engines</td>
</tr>
<tr>
<td></td>
<td>Encourages entrepreneurial culture</td>
<td>Risk-adverse culture</td>
</tr>
<tr>
<td></td>
<td>Better linked to emerging technologies (e.g., devices)</td>
<td></td>
</tr>
</tbody>
</table>

From the Federal Cloud Computing Strategy

- HPC Centers run at >90% CPU utilization and >90% scheduled utilization.
- HPC Centers partner with Vendors to field cutting edge systems
- HPC more aggressive with technical risks
## Enterprise IT versus HPC

<table>
<thead>
<tr>
<th></th>
<th>Traditional Enterprise IT</th>
<th>HPC Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Load Average</strong></td>
<td>30% *</td>
<td>90%</td>
</tr>
<tr>
<td><strong>Computational Needs</strong></td>
<td>Bounded computing requirements – Sufficient to meet customer demand or transaction rates. (i.e. If you gave a typical business free computing, would they suddenly be able to take advantage of it?)</td>
<td>Virtually unbounded requirements – Scientist always have larger, more complicated problems to simulate or analyze.</td>
</tr>
<tr>
<td><strong>Scaling Approach</strong></td>
<td>Scale-in. Emphasis on consolidating in a node using virtualization</td>
<td>Scale-Out Applications run in parallel across multiple nodes.</td>
</tr>
</tbody>
</table>
Cloud Misconceptions

- Clouds are simple to use and don’t require system administrators.
- My job will run immediately in the cloud.
- Clouds are more efficient.
- Clouds allow you to *ride* Moore’s Law without additional investment.
- Commercial clouds are much cheaper than operating your own system.
The cost of a standard cloud instance has dropped 18% over 5 years. Meanwhile, cores per socket have increased 2x-5x per socket in the same time-frame at roughly constant cost.
Cloud Misconceptions

- Clouds are simple to use and don’t require system administrators.
- My job will run immediately in the cloud.
- Clouds are more efficient.
- Clouds allow you to *ride* Moore’s Law without additional investment.
- Commercial Clouds are much cheaper than operating your own system.
## Cost of NERSC in the Cloud

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute Systems (1.38B hours)</td>
<td>$180,900,000</td>
</tr>
<tr>
<td>HPSS (17 PB)</td>
<td>$12,200,000</td>
</tr>
<tr>
<td>File Systems (2 PB)</td>
<td>$2,500,000</td>
</tr>
<tr>
<td><strong>Total (Annual Cost)</strong></td>
<td><strong>$195,600,000</strong></td>
</tr>
</tbody>
</table>

Assumes 85% utilization and zero growth in HPSS and File System data. Doesn’t include the 2x-10x performance impact that has been measured. This still only captures about 65% of NERSC’s $55M annual budget.

No consulting staff, no administration, no support.
Where are (commercial) clouds effective?

- Individual projects with high-burst needs.
  - Avoid paying for idle hardware
  - Access to larger scale (elasticity)
  - Alternative: Pool with other users (condo model)

- High-Throughput Applications with modest data needs
  - Bioinformatics
  - Monte-Carlo simulations
  - Cost issues still apply

- Infrastructure Challenged Sites
  - Facilities cost >> IT costs
  - Consider the long-term costs

- Undetermined or Volatile Needs
  - Use Clouds to baseline requirements and build in-house
Is an HPC Center a Cloud?

- Resource pooling.
- Broad network access.
- Measured Service.
- Rapid elasticity.
  - Usage can grow/shrink; pay-as-you-go.
- On-demand self-service.
  - Users cannot demand (or pay for) more service than their allocation allows
  - Jobs often wait for hours or days in queues

From the NIST definition for Cloud Computing
Cloud computing is a business model. It can be applied to HPC systems as well as traditional clouds. To achieve on-demand elasticity, one can:

- Idle hardware (at ownership cost)
- Sharing cores/nodes (at performance cost)
- Scheduling policies (pre-emption)
Closing Remarks

• Cloud Computing as it exist today is not ready for HPC
  – Overhead to convert to Cloud environments
  – Virtual instances underperform bare-metal systems
  – Less cost-effective than most large centers

• Traditional HPC resource providers can learn from the Cloud (Magellan presentation will discuss this)
Acknowledgements

- Lavanya Ramakrishnan
- Iwona Sakrejda
- Tina Declerck
- Others
  - Keith Jackson
  - Nick Wright
  - John Shalf
  - Krishna Muriki
    (not picture)
Thank you!

Contact Info:
Shane Canon
Scanon@lbl.gov
magellan.nersc.gov