Outsourcing Ecosystem for Science: Applications and Patterns

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Nimbus Components

Nimbus Platform

- Context Broker
- Cloudinit.d
- Elastic Scaling Tools

Enable users to use IaaS clouds

Nimbus Infrastructure

- Workspace Service
- Cumulus

Enable providers to build IaaS clouds

Enable developers to extend, experiment and customize
On the Nimbus Team...

Do whatever it takes to enable Infrastructure clouds for science

Applications and Patterns

How do we turn a “bad cloud” Into a “good cloud”?
STAR: a nuclear physics experiment at Brookhaven National Laboratory

Approach:

- Nimbus Science Clouds -> EC2 runs
- Virtual OSG clusters with Nimbus Context Broker

Impact:

- Production runs on EC2 since 2007
- The Quark Matter 2009 deadline: producing just-in-time results
- The small issues of cost

Priceless?

- Compute costs: $ 5,630.30
  - Fd%sf 300+ nodes over ~10 days,
  - Instances, 32-bit, 1.7 GB memory:
    - EC2 default: 1 EC2 CPU unit
    - High-CPU Medium Instances: 5 EC2 CPU units (2 cores)
  - ~36,000 compute hours total
- Data transfer costs: $ 126.30
  - Small I/O needs
- Storage costs: $ 4.61
  - Images only, all data
- Producing the result

The people: STAR @ MIT – Adam Kocoloski, Jan Balewski, Mathew Walker

Our test

- A 100 jobs, week long simulation cost ~ $1,510
- A year long CPU @ 100 jobs saturation ~ 79k$
- EC2+Nimbus
  - 300+ nodes for 10 days in 2008 (non-optimized) ~ $5,600

Work by Jerome Lauret (BNL) et al.
The emergent need for processing

A virtual appliance for automated and portable sequence analysis

Approach:
- Running on Nimbus Science Clouds, Magellan and EC2
- A platform for building appliances representing push-button pipelines

Impact
- From desktop to cloud
- http://clovr.org
• Detailed analysis of data from the MACHO experiment Dark Matter search
• Provide infrastructure for six observational astronomy survey projects
• Approach:
  – Running on a Nimbus cloud on WestGrid
  – Appliance creation and management
  – Dynamic Condor pool for astronomy
• Status:
  – In production operation since July 2010
Sky Computing

• Sky Computing = a Federation of Clouds

• Approach:
  – Combine resources obtained in multiple Nimbus clouds in FutureGrid and Grid’5000
  – Combine Context Broker, ViNe, fast image deployment
  – Deployed a virtual cluster of over 1000 cores on Grid5000 and FutureGrid – largest ever of this type

• Grid’5000 Large Scale Deployment Challenge award
• Demonstrated at OGF 29 06/10
• TeraGrid ’10 poster
• More at: www.isgtw.org/?pid=1002832

“Sky Computing”
IEEE Internet Computing, September 2009
Canadian Efforts

- BaBar Experiment at SLAC in Stanford, CA
- Using clouds to simulating electron-positron collisions in their detector
- Exploring virtualization as a vehicle for data preservation
- Approach:
  - Appliance preparation and management
  - Distributed Nimbus clouds
  - Cloud Scheduler
- Running production BaBar workloads

<table>
<thead>
<tr>
<th>Resource</th>
<th>Cores</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FutureGrid @Argonne Lab</td>
<td>100 Cores Allocated</td>
<td>Resources allocation to support BaBar</td>
</tr>
<tr>
<td>Elephant Cluster @UVic</td>
<td>88 Cores</td>
<td>Experimental cloud cluster hosts (xrootd for cloud)</td>
</tr>
<tr>
<td>NRC Cloud in Ottawa</td>
<td>68 Cores</td>
<td>Hosts VM image repository (repoman)</td>
</tr>
<tr>
<td>Amazon EC2</td>
<td>Proportional to $</td>
<td>Grant funding from Amazon</td>
</tr>
<tr>
<td>Hermes Cluster @UVic</td>
<td>Variable (280 max)</td>
<td>Occasional Backfill access</td>
</tr>
</tbody>
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7/18/11
More About

• Searching for the W-boson -- and nearly finding it!
• Typical timelines:
  – 5 months of data taking
  – 10 months of detector calibration, reconstruction and analysis

• Benefits of running in the cloud:
  – Reducing "time to science" (by ~ 6 months)
  – Near real-time processing
• Large NSF-funded observatory with requirements for adaptive, reliable, elastic computing.

• Approach:
  – Private Nimbus regional clouds -> commercial clouds
  – Highly available services that provision resources on many clouds based on need
  – Significant OOI CI infrastructure in data and sensor management based on this model

• Status:
  – Scalability and reliability tests on 100s of EC2, FutureGrid and Magellan resources
  – HA elastic services release in 2011 (Nimbus 3)
Nimbus Platform
Nimbus Platform: Working with Hybrid Clouds

Creating Common Context
Allow users to build turnkey dynamic virtual clusters

Nimbus Elastic Provisioning
- interoperability
- automatic scaling
- HA provisioning
- policies

private clouds (e.g., FNAL)
community clouds (e.g., FutureGrid)
public clouds (e.g., EC2)

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Context Broker

• Contextualization
  – Shared trust/security context
  – Shared configuration/context information

• Applications
  – Turnkey virtual clusters
  – Adding provisioned resources to a site or a domain

• Features
  – Work with any appliance, any provider, and across multiple providers
A Simplified Deployment Scenario
Cloudinit.d

- Repeatable deployment: write a launch plan once, deploy many times
- Coordination of inter-dependent launches via attributes
- Deploy on cloud and non-cloud resources from many providers
- User-defined launch tests (assertions)
- Test-based monitoring
- Policy-driven repair of a launch
- Lightweight and easy to use
- **Currently in RC1**
- **Come to our talk at TG’11 tomorrow!**
Elasticity, Reliability and Failure

Elasticity and reliability are different sides of the same coin.

- 2008: The ALICE proof-of-concept
- 2009: ElasticSite prototype
- 2009: OOI pilot

Challenge: a generic HA elastic service model

Paper: “Elastic Site”, CCGrid 2010
Elasticity, Reliability and Failure

- **Assumption:** a workload queue
  - ALiEn, PBS, AMQP,…
- **React to sensor information**
  - Queue, deployment status, VM health…
- **Evaluate against policies**
- **Scale to demand**
  - Across different cloud providers
  - Use contextualization to integrate machines across hybrid clouds
  - Scalable: latest tests scale to 100s of nodes on EC2, target is thousands
  - Highly Available – designed to support resiliency of all components
- **Release later in 2011**
  - Customizable to input, policy, decision engine, provider, etc.
Elastic Scaling Tools: Towards “Bottomless Resources”

• Early efforts:
  – 2008: The ALICE proof-of-concept
  – 2009: ElasticSite prototype
  – 2009: OOI pilot

• **Challenge**: a generic HA Service Model
  – React to sensor information
  – Queue: the workload sensor
  – Scale to demand
  – Across different cloud providers
  – Use contextualization to integrate machines into the network
  – Customizable
  – Routinely 100s of nodes on EC2

• **Coming in Nimbus 3**
The Nimbus Team
The Nimbus Team

- Project lead: Kate Keahey, ANL&UC
- Committers:
  - Tim Freeman - University of Chicago
  - Ian Gable - University of Victoria
  - David LaBissoniere - University of Chicago
  - John Bresnahan - Argonne National Laboratory
  - Patrick Armstrong - University of Victoria
  - Pierre Riteau - University of Rennes 1, IRISA
- Github Contributors:
  - Tim Freeman, David LaBissoniere, John Bresnahan, Pierre Riteau, Alex Clemesha, Paulo Gomez, Patrick Armstrong, Matt Vliet, Ian Gable, Paul Marshall, Adam Bishop
- And many others
  - See http://www.nimbusproject.org/about/people/
Parting Thoughts

• Cloud Computing Challenge: Outsourcing
  – Benefits
    • Economy of scale, access to different resources, no operation overhead, more flexible use
  – Criteria
    • Does it provide the right offering? Is it scalable? Easy to use? Easy to outsource? Cost-effective?

• Changing patterns of how people work
  – On-demand availability, acceptance of bursty demand, ease-of-portability

• Many challenges left!
Let’s make cloud computing for science happen.