The OpenNebula Cloud Toolkit: Experiences and Outlook

Borja Sotomayor
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What is OpenNebula?
Experiences
Ecosystem
Outlook
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What is OpenNebula?

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Outlook
IaaS

Public Interface

Virtual Infrastructure Manager

Physical resources with Virtual Machine Managers (Xen, KVM, VMWare, etc.)
Virtual Infrastructure Manager

Public Interface

Physical resources with Virtual Machine Managers (Xen, KVM, VMWare, etc.)

Internal Interface

Private Cloud

Hybrid Cloud

External Users

Internal Users
OpenNebula is a standards-based open-source toolkit to build private, public and hybrid clouds.

Most development takes place at the University Complutense of Madrid, and is funded by several European and Spanish grants. Project has been ongoing since 2005.

* Managing VMs is a big part of building an IaaS cloud, but not the only part.
**Why a “toolkit”?**

<table>
<thead>
<tr>
<th>End-User</th>
<th>Sysadmin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wants cloud interfaces to manage virtual machines, network and storage.</td>
<td>Wants administration interface.</td>
</tr>
<tr>
<td>Prefers popular interfaces like Amazon EC2</td>
<td>Needs control over resource allocation policies</td>
</tr>
<tr>
<td>Multi-tier services as a basic management entity</td>
<td>May have to support existing data center services.</td>
</tr>
<tr>
<td>Wants cloudbursting to public clouds and possibly to partner clouds.</td>
<td>Needs to integrate with products and services in the virtualization/cloud ecosystem such as cloud providers, hypervisors, virtual image managers, service managers, management tools, schedulers…</td>
</tr>
<tr>
<td>Cloudbursting must be transparent to users</td>
<td>Must be easy to add new functionality and to embed into other platforms.</td>
</tr>
</tbody>
</table>

One solution does not fit all requirements and constraints.
The OpenNebula design philosophy

There cannot be turnkey solutions for IaaS clouds, so OpenNebula shouldn't aim to be one.

First and foremost, provide an architecture that is open, flexible, and extensible that allows multiple components to be orchestrated.

Provide some components of our own, but allow them to be easily replaceable by others.
Seriously, though, what is OpenNebula?
Handles orchestration of all the different components. Also handles some cross-cutting features, such as user management, persistence, etc.
Provides a layer of abstraction over lower-level operations.

Drivers are self-contained and can be written without modifying OpenNebula's core.
Images on shared NFS

SCP from image repository

LVM

Contextualization of disk images
Creation of virtual networks
OpenNebula API

OpenNebula Core

Driver API

Virtualization

Storage

Network

Cloud

Interfaces

Schedulers

XML-RPC

CLI

OpenNebula Cloud API
Matchmaking scheduler with a configurable ranking policy

Geared towards immediate scheduling, with basic queueing
How does it compare to other solutions?

SurfNET, SURFnet cloud computing solutions, University of Amsterdam. 03/12/2010
http://tinyurl.com/surfnet-opennebula

BiG Grid, Virtualization of worker nodes, Working group progress report. 02/02/2010
http://tinyurl.com/big-opennebula


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A team at Clemson University and CERN has used OpenNebula to deploy up to ~8,000 VMs on 500 physical hosts running Xen.

These VMs are used to run batch jobs (submitted via WLCG CE and managed by LSF)

Used XML-RPC API to add certain autonomic functionality that was important to them, and to integrate with CERN's Quattor (http://www.quattor.org/)

Created, and contributed, drivers for using LVM-based disk images.

More details at
http://tinyurl.com/opennebula-blog-cern
The D-Grid (national German Grid initiative) Resource Center Ruhr (DGRZR) has used OpenNebula to manage 250 Blades with a total of 2,000 cores.

Entire D-Grid software stack is run on VMs. Grid worker nodes currently managed with OpenNebula, frontend nodes to follow shortly.

More details at http://tinyurl.com/opennebula-blog-dgrzr
SARA is the Dutch National High Performance Computing and e-Science Support Center, and the Dutch supernode in the international Science Grid.

They are currently developing an HPC cloud that uses OpenNebula. Users get their own 'Virtual Private HPC Cluster'

Starting with 128 cores across 16 physical machines running KVM.

Users use a management console developed at SARA to request a new VM. Templates are provided, but users can also configure their own.

More details at
http://tinyurl.com/sara-opennebula and
http://tinyurl.com/opennebula-sara-cfengine
The BiG Grid Virtual Machine Working Group (in NIKHEF) did an evaluation of several cloud solutions, and recommended using OpenNebula for managing worker node VMs in BiG Grid.

More details at http://tinyurl.com/big-opennebula
www.reservoir-fp7.eu

Commercial Service Managers

Commercial Infrastructure Provider

Source: RESERVOIR Project
Research with OpenNebula

Cloud architectures, federation, interoperability

– B. Sotomayor, R. S. Montero, I. M. Llorente and I. Foster, Virtual Infrastructure Management in Private and Hybrid Clouds, IEEE Internet Computing, September/October 2009 (vol. 13 no. 5)


High Performance Computing (HPC) clouds

– R. Moreno, R. S. Montero, e I. M. Llorente, Elastic Management of Cluster-based Services in the Cloud, First Workshop on Automated Control for Datacenters and Clouds (ACDC09)


– B. Sotomayor, R. S. Montero, I. M. Llorente and I. Foster, Resource Leasing and the Art of Suspending Virtual Machines, IEEE International Conference on High Performance Computing and Communications (HPCC-09), Seoul, Korea
Research with OpenNebula

Service Management


Energy-efficient cloud computing

OpenNebula in industry

CloudScaling (http://cloudscaling.com/) According to Randy Bias, CEO, “Cloudscaling has had great success with OpenNebula. Unlike many of the other open source virtual infrastructure management tools, ONE is cleanly written, modular, and easily extensible. We use it regularly in our labs and in some client engagements. Highly recommended.”

Morph Labs (http://www.mor.ph/) uses OpenNebula in its mCloud Controller product.
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More featureful scheduler, including support for advance reservation, queueing, and pluggable scheduling policies.

Developed at the University of Chicago

http://haizea.cs.uchicago.edu/
Haizea is a lease manager that can act as a scheduling backend for OpenNebula, providing advanced functionality such as:

- Advance reservation of capacity
- Best-effort scheduling with backfilling
- Resource preemption (using VM suspend/resume/migrate)
- Policy engine, allowing developers to write pluggable scheduling policies in Python
- Includes a simulation mode (useful for researchers testing scheduling algorithms)

Haizea research publications: http://haizea.cs.uchicago.edu/pubs.html
**scp-wave**
Disk image deployment in $O(\log n)$ time
Developed at Clemson University

[https://code.google.com/p/p/scp-wave/](https://code.google.com/p/p/scp-wave/)
Virtual Cluster Tool

Instantiate, deploys and saves virtual clusters as atomic, self-consistent entities.

Developed at Center for Advanced Studies, Research and Development in Sardinia

http://dc.crs4.it/projects/vida
**Deltacloud driver and adaptor**

OGF OCCI API driver for the RedHat DeltaCloud Framework.

http://deltacloud.org/drivers.html

Adaptor for hybrid cloud computer

http://dev.opennebula.org/projects/deltacloud-adaptor/wiki
Chef recipes
A collection of Chef recipes to automate deployment and management of an OpenNebula cluster.
http://www.cloudboot.com/
OpenNebula Express
Installer that eases the installation and deployment of OpenNebula clouds.
http://dev.opennebula.org/projects/opennebula-express/wiki
SNMP Information Driver
Allows Opennebula to use SNMP to monitor host nodes rather than the default SSH.
http://opennebula.org/software:ecosystem:snmp_im__driver
Libcloud driver
OGF OCCI API driver for Apache Libcloud
http://incubator.apache.org/libcloud/
Management Console
Web interface for OpenNebula
Developed at SARA, Academic HPC center of Amsterdam
http://dev.opennebula.org/projects/management-console
Google Summer of Code 2010 projects

Management Console (II)

Service Manager

Improving Haizea+OpenNebula integration
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OpenNebula 2.0 Features

Image repository

Improved scalability

Multi-cluster support

Authentication/Authorization drivers

Improved EC2 support

MySQL support

More details:
http://tinyurl.com/opennebula-2-0-beta1
OpenNebula 2.0

July 28 → Beta 1
August 31 → Beta 2
September 6 → Release Candidate
September 14 → Final release
Research funding guaranteed until 2013

- RESERVOIR – Resources and Services Virtualization without Barriers, 2008-2011, EU grant agreement 215605
- HPCcloud - Distributed Virtual Infrastructures to Provision Resources, 2010-2012, MICINN TIN2009-07146
- MEADIANET - Integración de Servicios Multimedia de Siguiente Generación en la Internet del Futuro, 2010-2013, Comunidad de Madrid S2009/TIC-1468
- Recently approved: StratusLab, BonFIRE, 4CAAST
Y0: Grid/community services running directly on RC hardware.
Y1: Grid services running on private clouds. Scaling out to commercial providers possible.
Y2: Cloud API provided. Virtualized machines available to end users.
Y3: Community services run on standard resources via StratusLab cloud API.
Y4: Additional community services and novel services built on top of cloud API.

More details: http://tinyurl.com/opennebula-blog-stratuslab
C12G Labs is a privately-held, self-funded company, started by the authors of OpenNebula in order to provide value-added enterprise-grade solutions around it.

http://www.c12g.com/
Questions?
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