Cloud Computing and its Applications
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OpenNebula
An Innovative Open Source Toolkit for Building Cloud Solutions

Ignacio M. Llorente
dsa-research.org

Distributed Systems Architecture Research Group
Universidad Complutense de Madrid
### Position in the Cloud Ecosystem

**OpenNebula - An Innovative Open Source Toolkit for Building Cloud Solutions**

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-demand access to any application</td>
<td>End-user (does not care about hw or sw)</td>
</tr>
<tr>
<td></td>
<td><a href="https://www.skype.com">skype</a>, <a href="mailto:">Gmail</a>, <a href="https://www.facebook.com">Facebook</a></td>
</tr>
<tr>
<td>Platform for building and delivering web applications</td>
<td>Developer (no managing of the underlying hw &amp; sw layers)</td>
</tr>
<tr>
<td></td>
<td><a href="https://azure.microsoft.com">Windows Azure</a>, <a href="https://www.salesforce.com">Salesforce</a></td>
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**OpenNebula.org**

Innovative open, flexible and scalable technology to build IaaS clouds
Contents

OpenNebula - An Innovative Open Source Toolkit for Building Cloud Solutions

Innovations
Designed to address the technology **challenges** in cloud computing management from **business use cases**

OpenNebula.org

**Toolkit**
OpenNebula v1.4

**Community**
Users, projects and ecosystem
The Innovations: Infrastructure User View

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Elastic Multi-tier Services

- Service as basic management entity
- Cloud Restful interface and CLI to manage virtual machines, network and storage
- Concurrent support for other popular interfaces (Amazon EC2)

Service as Groups of VMs

- Service components in VMs
- Inter-connection relationship
- Placement constraints
The Innovations: Infrastructure Manager View

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Flexible, Efficient and Scalable Management of the Cloud

- Administration interface for the centralized monitoring and management of the infrastructure
- Support for the definition of workload and resource-aware allocation policies such as consolidation (energy efficiency), load balancing, affinity-aware, capacity reservation...
- Integration with existing management tools in the data center

Scalable back-end
- Virtualization
- Storage
- Networking
The Innovations: Infrastructure Manager View

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Hybrid Cloud Computing and Federation

- **Cloud bursting** at infrastructure layer, fully transparent to users
- Scale-out decisions are taken by infrastructure administrators according to business policies

Two levels of Collaboration
- Extend the private cloud using both partner and commercial clouds
- Create a federation of clouds
The Innovations: System Integrator View

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Open Architecture, Interfaces and Code

- **Integration with any product and service** in the virtualization/cloud ecosystem such as cloud providers, hypervisors, virtual image managers, service managers, management tools, schedulers…
- **Support to build any type of deployment**: private, public, hybrid and community clouds
- **Easy to enhance** to support new functionality
- **Easy to embed** into other Cloud applications and platforms
- **Liberal open-source license**

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Out-of-the-box Cloud Solution

Embedded VM Orchestrator in PaaS and SaaS Solution

Platform for Innovative Projects
The Toolkit: OpenNebula 1.4

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One Size does not Fit All: Tailoring the Tool to Fit your Needs

• Open, modular and extensible architecture
• Minimal installation requirements (distributed in Ubuntu)
• Open Source – Apache 2

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OpenNebula API

Virtual and Physical Resource Management

Driver API

Compute

Storage

Network

Cloud

Interfaces

Schedulers
# The Toolkit: Building a Private Cloud

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## Features and Functions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal Interface</strong></td>
<td>• Unix-like CLI for fully management of VM life-cycle and resources</td>
</tr>
<tr>
<td></td>
<td>• XML-RPC API and libvirt virtualization API</td>
</tr>
<tr>
<td><strong>Scheduler</strong></td>
<td>• Requirement/rank matchmaker allowing the definition of workload</td>
</tr>
<tr>
<td></td>
<td>• and resource-aware allocation policies</td>
</tr>
<tr>
<td></td>
<td>• Support for advance reservation of capacity through Haizea</td>
</tr>
<tr>
<td><strong>Virtualization Management</strong></td>
<td>• Xen, KVM, and VMware</td>
</tr>
<tr>
<td><strong>Image Management</strong></td>
<td>• General mechanisms to transfer and clone VM images</td>
</tr>
<tr>
<td><strong>Network Management</strong></td>
<td>• Definition of isolated virtual networks to interconnect VMs</td>
</tr>
<tr>
<td>**Service Management and</td>
<td>• Support for multi-tier services consisting of groups of inter-</td>
</tr>
<tr>
<td>Contextualization**</td>
<td>• connected VMs, and their auto-configuration at boot time</td>
</tr>
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</table>
The Toolkit: Building a Public Cloud

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<table>
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<tr>
<th>Feature</th>
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<tbody>
<tr>
<td>Cloud Interfaces for Users</td>
<td>• Implementation of a subset of the EC2 Query API and OGF - OCCi</td>
</tr>
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</table>

Flexibility
• The Cloud Service allows the implementation of new Cloud interfaces
The Toolkit: Building a Hybrid Cloud

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<tr>
<td>Cloud Plugins</td>
<td>• Amazon EC2 and ElasticHosts connectors</td>
</tr>
<tr>
<td>Federation</td>
<td>• Support for simultaneous access to several remote clouds</td>
</tr>
<tr>
<td>Flexibility</td>
<td>• Modular approach to develop new connectors</td>
</tr>
</tbody>
</table>
The Community: Users and Projects

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Users (Different Levels of Use: From Experimental to Production)

- ESA (European Space Astronomy Centre)
- CERN
- NIKHEF
- NCHC
- CS2
- VSTORM
- MinuTree
- Telefónica
- MPS

Projects

- Reservoir
- StratusLab
- EGEE (Enabling Grids for E-sciencE)
The Community: Projects

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Collaboration between RESERVOIR and EGEE

- **OpenNebula for cloud computing solution** in the following scenarios
  - Dynamic Provisioning of EGEE Site Worker Nodes
  - Expanding the Computing Capacity of a EGEE Site using Cloud resources
  - Deployment of a Virtualized EGEE Site to a Public Cloud
The Community: Active Ecosystem

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Components around OpenNebula

• **Haizea Lease Manager (University of Chicago):** Advance reservation of capacity and queuing of best effort requests

• **RESERVOIR Policy Engine (IBM Haifa/Elsag Datamat):** Policy-driven probabilistic admission control and dynamic placement optimization to satisfy site level management policies

• **VM Consolidation Scheduler (UCM):** Periodic re-placement of VMs for server consolidation and suspension/resume of physical resources

• **Virtual Cluster Tool (CRS4 Distributed Computing Group):** Atomic virtual cluster management with versioning and multiple transport protocols.

• **Nephele (Telefonica I+D):** SLA-driven automatic service management

• **Under Development:** SUN Cloud API, vCloud API, VirtualBox plugin, dashboard for infrastructure management, new schedulers, SLA and security framework, Grid service manager, LVM and SAN support,…

• …
Haizea Lease Manager

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)
- Open source (Apache 2)

http://haizea.cs.uchicago.edu/
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More info, downloads, mailing lists at www.OpenNebula.org

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www.reservoir-fp7.eu/

References

• 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)

The OpenNebula Team

• Ruben S. Montero, Rafel Moreno, Tino Vazquez, Javier Fontan and Jaime Melis