The OpenNebula Standard-based Open-source Toolkit to Build Cloud Infrastructures

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### Cloud Computing in a Nutshell

**The OpenNebula Standard-based Open-source Toolkit to Build Cloud Infrastructures**

<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>Platform for building and delivering web applications</td>
<td>Developer (no managing of the underlying hw &amp; sw layers)</td>
</tr>
</tbody>
</table>

**Software as a Service**

- End-user (skype, Gmail, Facebook)

**Platform as a Service**

- Developer (Windows Azure, force.com)

**Infrastructure as a Service**

- Physical Infrastructure

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**OpenNebula.org**

Innovative open, flexible and scalable technology to build IaaS clouds
From Public to Private Cloud Computing
The OpenNebula Standard-based Open-source Toolkit to Build Cloud Infrastructures

Public Cloud
• Flexible and elastic capacity
• Ubiquitous network access
• On-demand access
• Pay per use

Private Cloud
• Centralized management
• VM placement optimization
• Dynamic resizing and partitioning of the infrastructure
• Support for heterogeneous workloads
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Contents

Innovations
Designed to address the technology challenges in cloud computing management

Toolkit
OpenNebula v1.4

Community
Users, projects and ecosystem

Open-source and Standardization
Ongoing efforts
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The Innovations: Infrastructure User View

Elastic Multi-tier Services

- Service as basic management entity
- Cloud Restful interface and CLI to manage virtual machines, network and storage => Based on an open standard
- 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

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

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

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Hybrid Cloud Computing and Federation

- *Cloudbursting* 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
- Minimum installation requirements (distributed in Ubuntu)
- Open Source – Apache 2

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**Interfaces**

**Schedulers**

**OpenNebula API**

**Virtual and Physical Resource Management**

**Driver API**

**Compute**

**Storage**

**Network**

**Cloud**
## Feature Function

### Internal Interface
- Unix-like CLI for fully management of VM life-cycle and resources
- XML-RPC API and libvirt virtualization API

### Scheduler
- Requirement/rank matchmaker allowing the definition of workload and resource-aware allocation policies
- Support for advance reservation of capacity through Haizea

### Virtualization Management
- Xen, KVM, and VMware

### Image Management
- General mechanisms to transfer and clone VM images

### Network Management
- Definition of isolated virtual networks to interconnect VMs

### Service Management and Contextualization
- Support for multi-tier services consisting of groups of inter-connected VMs, and their auto-configuration at boot time
The Toolkit: Building a Public Cloud

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<table>
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<th>Feature</th>
<th>Function</th>
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<tr>
<td><strong>Cloud Interfaces for Users</strong></td>
<td>• Implementation of a subset of the EC2 Query API and OGF - OCCI</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>• The Cloud Service allows the implementation of new Cloud interfaces</td>
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</tbody>
</table>
### Feature | Function
--- | ---
Cloud Plugins | • Amazon EC2 and ElasticHosts connectors
Federation | • Support for simultaneous access to several remote clouds
Flexibility | • Modular approach to develop new connectors
The Community: Users

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

Projects
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/
Open-source and Standardization: Other Technologies

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Other Open-Source Technologies

- **Eucalyptus**
  - Compatible with **Amazon EC2 interfaces** and designed to support additional client-side interfaces
  - Exposes EC2 and WSRF interfaces and offers self-configuring virtual cluster support
  - Management of clusters and virtual machines through a single easy to use interface

- **Nimbus**

- **enomaly**

Commercial Software

- **VMware vSphere™**
  - **VMware** solution for private cloud computing

- **Platform ISF**
  - **Infrastructure sharing software** for physical and virtual resources
Open-source and Standardization: Existing Efforts

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A Positioning of Cloud Standards

Proprietary APIs e.g. Amazon Web Services

“Cloud”

Current scenario

Private Cloud

Hybrid Cloud

Proprietary APIs

Possible future scenario
(Corporates & Federal Agencies)

“Storefront”

Standard APIs

Public Cloud

Enabling technologies

OASIS

SaaS

PaaS

DaaS

IaaS

OCCI

OpenGridForum

“or”

Proprietary APIs e.g. Amazon Web Services

courtesy of Enrico Ronco, Telecom Italia

cloud-standards.org

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Open-source and Standardization: Interface Standard

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OGF OCCI Open Cloud Computing Interface

operation: GET http://abc.com/compute/uid123foobar/

Provider

Instance

Operations

Compute

Network

Storage

Resources can be linked

Operations operate on resources (start, stop, delete, update)

Covered by OCCI
IT Resources will be the Next Utility

- Future enterprise datacenters will look like private Clouds supporting a flexible and agile execution of virtualized services, and combining local with public Cloud-based infrastructure to enable highly scalable hosting environments.

- Growing number of domain specific and regional Cloud providers implementing a utility computing business model by offering pay per use resources on-demand.

- Public Clouds will be supported by a network of geographically distributed datacenters for high availability, end-user service proximity, legal and policy issues…

- Public Clouds will be interconnected to meet fluctuating demands.

- Grid sites will offer infrastructure cloud-like interfaces to address the new resource access demands from the community.
The Open Source Toolkit to Build Cloud Infrastructures

More info, downloads, mailing lists at www.OpenNebula.org

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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)

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