Des grilles aux Clouds
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OpenNebula
Cloud Case Studies
for Research and Industry

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OpenNebula: Cloud Case Studies for Research and Industry

Cloud as an Evolution of the Data Center
Addressing the constraints of your infrastructure environment and the requirements of your business use cases

OpenNebula Toolkit
Fully open source, thoroughly tested, flexible, extensible and with excellent performance and scalability to manage tens of thousands of VMs

Cloud Computing Case Studies
Examples of cloud infrastructures and large projects using OpenNebula as cloud management tool
## A Model for Delivering IT Capabilities

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Software as a Service</strong></td>
<td><strong>End-user</strong></td>
</tr>
<tr>
<td>On-demand access to any application</td>
<td>(does not care about hw or sw)</td>
</tr>
<tr>
<td><strong>Platform as a Service</strong></td>
<td><strong>Developer</strong></td>
</tr>
<tr>
<td>Platform for building and delivering web applications</td>
<td>(no managing of the underlying hw &amp; swlayers)</td>
</tr>
<tr>
<td><strong>Infrastructure as a Service</strong></td>
<td><strong>System Administrator</strong></td>
</tr>
<tr>
<td><strong>Raw computer infrastructure</strong></td>
<td>(complete management of the computer infrastructure)</td>
</tr>
</tbody>
</table>

### Physical Infrastructure

- GOGGRID
- rackspace
- amazone webservices

### Software as a Service

- Skype
- Gmail
- Facebook

### Platform as a Service

- Windows Azure
- force.com

### Infrastructure as a Service

- flexiscale
IaaS Cloud Computing

Private Cloud Computing => A “Public Cloud behind the firewall”
- Simplify and optimize internal operations
- Service flexibility and elasticity
- Higher utilization & operational savings
- Security concerns

Hybrid Cloud Computing => Utility Computing dream made a reality!
• Supplement the capacity of the Private Cloud
The Data Center is the Computer

Service End-Users

VIRTUAL INFRASTRUCTURE

OpenNebula.org

PHYSICAL INFRASTRUCTURE

Physical Storage

Virtual Machine Managers

Physical Machines

Physical Networking

Remote Cloud

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An Evolution of the Data Center

Constraints from Existing Infrastructure and Processes

Requirements from Usage and Deployment Scenarios

“One solution does not fit all requirements and constraints. There cannot be turnkey quick cloud solutions”
An Evolution of the Data Center

Open Architecture, Interfaces and Code

- **Integration** with existing processes and management tools in the data center
- Support any security, monitoring, storage, networking and virtualization infrastructure service
- **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 extend** to support new functionality and **to embed** into other Cloud applications and platforms
- Based on **standards to** avoid vendor lock-in and to enable interoperability
- **Truly open-source**, not open core
- **Liberal open-source license**
Flagship International Projects in Cloud Computing
Result of many years of research and development in efficient and scalable management of virtual machines on large-scale distributed infrastructures.

Open-source Toolkit
Open platform for innovation to research the challenges that arise in cloud management, and production-ready tool in both academia and industry

• Started in 2005, first release in March 2008, and ONE 2.0 just released
• Open-source released under Apache v2.0, packaged for main Linux distributions
• Mailing lists for best-effort support and open development framework
• Development and roadmap definition driven by the community and projects
• Active and engaged open community and ecosystem
• >3,000 downloads/month (not including code repository and Ubuntu)
• Used in many production environments, distributed in commercial solutions and availability of commercial professional support by C12G Labs
• Long-term sustainability ensured by project funding and commercial sponsors
## Business Use Cases from Leading Companies

<table>
<thead>
<tr>
<th>Feature</th>
<th>Requirements of Enterprise Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload Profile</strong></td>
<td>Management of multi-tier services with security levels, placement constraints and automatic configuration</td>
</tr>
<tr>
<td><strong>Administration Interface</strong></td>
<td>Complete CLI to manage VMs, images, users, accounting, clusters, virtual networks, physical resources…</td>
</tr>
<tr>
<td><strong>Cloud Interfaces</strong></td>
<td>Support standard and most popular cloud interfaces</td>
</tr>
<tr>
<td><strong>Cloudbursting</strong></td>
<td>Combine local capacity with remote cloud resources</td>
</tr>
<tr>
<td><strong>Adaptability</strong></td>
<td>APIs and modular architecture to integrate with existing processes and management tools in the data center</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>Efficient Management of hundreds of thousands of VMs and multiple physical clusters</td>
</tr>
<tr>
<td><strong>Stability &amp; Robustness</strong></td>
<td>Production-ready thoroughly tested and mature technology</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Multi-tenancy, isolation and integration with security mechanisms and policies</td>
</tr>
<tr>
<td><strong>Openness and Standards</strong></td>
<td>Open interfaces and architecture, fully open-source code, and adopt and implement standards</td>
</tr>
<tr>
<td><strong>Interoperability and Portability</strong></td>
<td>Provide with choice across most popular cloud interfaces, hypervisors and public clouds and with a flexible software that can be installed in any hardware and software combination</td>
</tr>
<tr>
<td><strong>Cloud Administration</strong></td>
<td>Monitoring, accounting and logging</td>
</tr>
<tr>
<td><strong>Site Policy Enforcement</strong></td>
<td>Scheduling and user quota management</td>
</tr>
</tbody>
</table>
Capabilities for Cloud Management
Most advanced open-source toolkit offering unique features to administer the complexity of large-scale distributed infrastructures.

Capabilities for Integration
Open, flexible and extensible architecture, interfaces and components that fit into any existing data center.

Capabilities for Production Environments
Scalability and performance tested on very large-scale infrastructures consisting of thousands of cores, with the security and fault tolerance levels required in production.

Leverage the Vibrant Cloud Ecosystems
Leverage the ecosystems being built around OpenNebula and the most common cloud interfaces, Amazon AWS, OGC OCCI and VMware vCloud.

Fully Open Source Cloud Software
OpenNebula is NOT a feature or performance limited edition of an Enterprise version. OpenNebula is truly open, and not open core.
Openness

• Open architectures
• Open interfaces
• Open code

Adaptability

• Modular architectures

Standardization

• Use standards
• Implement standards

Portability

• It can be installed in any hardware and software
The OpenNebula Toolkit: Interoperability
The OpenNebula Toolkit: Adaptability

A Highly Modular Architecture to Fit into any Existing Datacenter

- Open, flexible and extensible architecture
- Provide basic components, but allow them to be easily replaceable by others
Cloud Case Studies: Enabling your Cloud

Open Source Community
- Open architecture and interfaces
- Open code and liberal license
- Open community and ecosystem

Management Tool

Innovation Tool

OpenNebula: Cloud Case Studies for Research and Industry
## Cloud Case Studies: Deployment Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Definition</th>
<th>Cloud Cases</th>
</tr>
</thead>
</table>
| **Private** | Infrastructure is owned by a single organization and made available only to the organization | • Optimize and simplify *internal operation*  
• *SaaS/PaaS* support  
• IT consolidation within *large organizations* (Goverment Clouds, University Clouds…) |
| **Public** | Infrastructure is owned by a single organization and made available to other organizations | • *Commercial cloud providers*  
• *Science public clouds* by ICT service centers to enable scientific and educational projects to experiment with cloud computing  
• *Special purpose clouds* with dedicated capabilities (HPC Clouds..) |
| **Hybrid** | Infrastructure is a composition of two or more clouds | • *Cloud bursting* to address peak demands  
• *Cloud Federation* to share infrastructure with partners  
• *Cloud Aggregation* to provide a larger resource infrastructure |
Private Cloud to Support Grid Site

- **Goal**: Execution of a virtualized Grid site in D-Grid and EGEE
- **Details**: The D-Grid Resource Center Ruhr (DGRZR) runs an OpenNebula private cloud on 248 blades and 1,984 cores with Xen

Public HPC Cloud

- **Goal**: OpenNebula is used to support the execution of virtual clusters and HPC applications
- **Details**: SARA High Performance Computing Center uses OpenNebula in its new HPC Cloud service
Cloud Case Studies: Computing Provider

- **Goal:** Easier management and new computing models in the batch farm

- **Example of Integration with Existing Infrastructure Environment**
  - **Configuration Management:** Quattor with lifecycle management and “self-notification” in OpenNebula
  - **Network Management:** Adapted to address network infrastructure requirements regarding fixed IP/MAC leases in each box
  - **Storage Management:** New LVM transfer scripts and a very fast parallel scp to push images to all the hosts

Source: CERN IT-PES/PS Group: Sebastien Goasguen, Ulrich Schwickerath, Ewan Roche and Belmiro Moreira
Cloud Case Studies: Telecom Provider

- **Goal**: Meet the growing demands for high performance, low cost, high scalability, high reliability of China Mobile IT Infrastructure (computing, storage); and the demands of China Mobile to deliver Internet business and services

- **Details**: 4,096 cores, Xen, Ganglia, and Hadoop

Source: China Mobile's Presentation at OpenCirrus Meeting
Cloud Case Studies: Tool for Innovation

Resources and Services Virtualization without Barriers

- Open source technology to enable deployment and management of complex IT services across different administrative domains

Service and Sw Architectures and Infrastructures

Agreement 215605 (2008-2011)
Cloud Case Studies: Tool for Innovation

Enhancing Grid Infrastructures with Cloud Computing
- Simplify and optimize its use and operation, providing a more flexible, dynamic computing environment for scientists; and
- enhance existing computing infrastructures with “IaaS” paradigms
Cloud Case Studies: Tool for Innovation

OpenNebula: Cloud Case Studies for Research and Industry

OpenNebula.org

Agreement 257386 (2010-2013)
New Infrastructure Paradigms and Experimental Facilities

Cloud Case Studies: Tool for Innovation

Building Service Testbeds on FIRE

- Design, build and operate a multi-site cloud-based facility to support research across applications, services and systems targeting services research community on Future Internet

www.BonFIRE-Project.eu

Source: BonFIRE Project

OpenNebula: Cloud Case Studies for Research and Industry
Cloud Case Studies: Tool for Innovation

Building the PaaS Cloud of the Future
- Create an advanced PaaS Cloud platform which supports the optimized and elastic hosting of Internet-scale multi-tier applications

Source: 4CaaSt Project
Outlook – IT Resources will be the Next Utility

• Future enterprise datacenters will operate like hybrid Clouds combining local with public Cloud-based infrastructure to enable highly scalable hosting environments

• Public Clouds will be supported by a network of geographically distributed datacenters for high availability, end-user service proximity, data regulatory issues…

• Growing number of domain specific Cloud providers

• Grid will operate like a federation of cloud infrastructures

… and we are at the beginning of the road, significant research is needed
Get Involved in the OpenNebula Community!

**Use the Technology and Give us Feedback**
- Support through several mailing lists or describe your use case in our blog
- Report bugs and make feature requests

**Spread our Word**
- Spread the word about OpenNebula and open source cloud computing

**Contribute to the Development**
- Open development infrastructure
- Provide patches for bug fixes or enhancements

**Contribute to the Quickly Growing Ecosystem**
- Submit a new tool or extension to the OpenNebula ecosystem

**Sponsor the Community**
- Provide funds or resources to support development or to organize events

**Innovation Alliance**
- Collaboration in open-source and innovation in cloud computing management
Research 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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- **C12G Labs** dedicates an amount of its own engineering resources to support and develop OpenNebula

The OpenNebula Community

- **The OpenNebula Team**: Ignacio M. Llorente, Ruben S. Montero, Tino Vazquez, Javier Fontan, Jaime Melis, Carlos Martín, Rafael Moreno, Daniel Molina, Borja Sotomayor…

  - … and many **value community contributors** from several organizations

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