Design and Building of IaaS Clouds

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## Position in the Cloud Ecosystem

**Design and Building of IaaS Clouds**

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
</tr>
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<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:">email</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>
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<td></td>
<td><a href="https://azure.microsoft.com">Windows Azure</a>, <a href="https://www.force.com">force.com</a></td>
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### Software as a Service

- **On-demand access to any application**
- Example: [skype](https://www.skype.com), [email](mailto:), [facebook](https://www.facebook.com)

### Platform as a Service

- **Platform for building and delivering web applications**
- Example: [Windows Azure](https://azure.microsoft.com), [force.com](https://www.force.com)

### Infrastructure as a Service

- **Physical Infrastructure**

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**OpenNebula.org**

Innovative open, flexible and scalable technology to configure your own IT resources into an IaaS cloud.
Transforming your IT Infrastructure into a Cloud

Design and Building of IaaS Clouds

Commercial Cloud Provider

- **Flexible** and **elastic capacity** to meet dynamic demands of service
- **Ubiquitous network access**
- **Pay per use** and on-demand access

Building your Own Cloud

- **Optimize and Simplify Internal Operations**
  - **Centralized management** of all servers and services with dynamic resizing of infrastructure and dynamic allocation of capacity
  - **Higher utilization** and **operational saving** of existing resources with server consolidation and removal of application silos
  - **Lower infrastructure expenses** with combination of local and remote Cloud resources
- **Support new IT, scientific, or business Cloud services**
# Deployment Models

## Design and Building of IaaS Clouds

<table>
<thead>
<tr>
<th>Model</th>
<th>Definition</th>
<th>Examples of Deployment</th>
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</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** (Government Clouds, University Clouds…)** |
| **Public** | Infrastructure is owned by a single organization and made available to other organizations | • **Commercial cloud providers**  
• **Community public clouds** by ICT service centers to enable scientific and educational projects to experiment with cloud computing  
• **Special purpose clouds** with dedicated capabilities (Science Clouds, HPC Clouds..)  
• **Regional clouds** to address regulatory or latency issues |
| **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 |
Designing a Cloud: A Design Driven by Requirements

Requirements from Usage and Deployment Scenarios

- **Users**: Functionality exposed and workload profile
- **Managers**: Flexible, efficient and scalable management of the Cloud
- **Business**: Hybrid cloud computing and federation
- **Integrators**: Open architecture, interfaces and code

“One solution does not fit all requirements and constraints, a properly architectured solution should fully align with your Cloud strategy”

Constraints from Existing Infrastructure and Processes in the Organization
Designing a Cloud: Flexible Cloud Manager

Design and Building of IaaS Clouds

Cloud Manager as Enabler to Build Your Own Cloud

OpenNebula Core

XMLRPC / CLI / OpenNebula Cloud API

Driver API

Compute, Storage, Network, Cloud

Interfaces, Schedulers

HAIZEA Matchmaking

Virtual Networks

SAN, DAS, NAS, ...
Designing a Cloud: Interoperability

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Interoperation from Different Perspectives

- Physical Infrastructure
- Private Cloud
- OpenNebula
- Hybrid Cloud
- Cloud Federation
- Remote Cloud
- OpenNebula
- ElasticHosts
- Amazon Web Services

Cloud Interface
Innovations
Technology challenges in cloud computing management from business use cases

Open-source Toolkit
OpenNebula v1.4

- **Open and flexible tool** to fit into any datacenter and integrate with any ecosystem component
- **Open-source** released under Apache v2.0, and distributed in Ubuntu
- **Most advanced solution** to build private, public, federated and hybrid clouds
- Based on and implements **standards to** avoid vendor lock-in and to enable interoperability
- **Efficient and scalable management** of the cloud
Building a Cloud: Experiences

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Different Levels of Use: From Experimental to Production
Building a Cloud: Experiences

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Deployment Cases

- A team at Clemson University and CERN has used OpenNebula to deploy thousands of VMs on 400 hosts (3,200 cores) running Xen
  - OpenNebula was integrated in internal network and configuration management
  - Contributed drivers for using LVM based disk images

- The Dgrid Resource Center Ruhr (DGRZR) has used OpenNebula to manage 248 Blades with a total of 1,984 cores.
  - OpenNebula is used to support the execution of a virtualized Grid site in D-Grid and EGEE

- SARA High Performance Computing Center uses OpenNebula in its new HPC Cloud service on 128 cores across 16 servers with KVM
  - OpenNebula is used to support the execution of virtual clusters and HPC applications
  - Authors of the OpenNebula Management Console
Open Community for Cloud Computing

- **Haizea Lease Manager (University of Chicago):** Advance reservation of capacity and queuing of best effort requests.
- **Cloud Management Console (SARA Computing and Networking Services):** Web interface for OpenNebula.
- **Virtual Cluster Tool (CRS4 Distributed Computing Group):** Atomic virtual cluster management with versioning and multiple transport protocols.
- **DeltaCloud Driver (DSA-Research@UCM):**
- **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 (DSA-Research@UCM):** Periodic re-placement of VMs for server consolidation and suspension/resume of physical resources.
- **Claudia (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,…
Building a Cloud: Innovative Projects

Design and Building of IaaS Clouds

European Projects on Cloud Computing Infrastructures

Resources and Services Virtualization without Barriers
- Open source technology to enable deployment and management of complex IT services across different administrative domains

Enhancing Grid Infrastructures with Cloud Computing
- Simplify and optimize its use and operation, providing a more flexible, dynamic computing environment for scientists.
- Enhance existing computing infrastructures with “IaaS” paradigms

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
Innovative Projects: The Enabling Software Artefacts

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Service Provider

Service Manager

VEE Manager

VEE Host

Telco  Utility  eGov  SAP

Commercial Service Managers

Commercial Infrastructure Provider

Source: RESERVOIR Project

www.reservoir-fp7.eu
Innovative Projects: Enhancing Grid with Cloud

Design and Building of IaaS Clouds

StratusLab  www.stratuslab.org

User Communities

Community Services

Grid Services

Cloud API

Novel Services
E.g. Hadoop, PaaS, Web 2.0

Community Services

Source: StratusLab Project

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.
Innovative Projects: Cloud for Service Experimentation

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Building Service Testbeds on FIRE

Source: BonFIRE Project
### Outlook

**Design and Building of IaaS Clouds**

### About the Short-term Roadmap (2 months): v1.6

<table>
<thead>
<tr>
<th>Feature</th>
<th>New Function</th>
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<tbody>
<tr>
<td>Scalability, Reliability</td>
<td>• Support for MySQL in the back-end</td>
</tr>
<tr>
<td>and High Availability</td>
<td>• Unit-testing of the core</td>
</tr>
<tr>
<td></td>
<td>• HTTP back-end</td>
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<tr>
<td>Functionality</td>
<td>• Image repository</td>
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<td></td>
<td>• Support for multiple clusters</td>
</tr>
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<td></td>
<td>• CLI for accounting and billing support</td>
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<tr>
<td>Cloud Interfaces</td>
<td>• Improve compatibility with EC2 ecosystem</td>
</tr>
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</table>

### About the Medium-term Roadmap

- **Projects** funding OpenNebula
- **Community**

### Funding

- New European Projects ensure the development and maintenance of OpenNebula until end of 2013
- C12G Labs also contributes to the sustainability of the open-source community
Long-term Sustainability and Commercial Support
Design and Building of IaaS Clouds

OpenNebula Enterprise Edition >
The Enterprise-grade Cloud Management Tool to Build your Cloud Solution, Product or Service

C12G.com
Thanks

Funding Agencies

- European Commission: RESERVOIR 2008-2011, EU agreement 215605
- Community of Madrid: MEADIANET 2010-2013 CAM S2009/TIC-1468

Other Sponsors

- 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

Your support and contribution are very much appreciated!
More Information

More info, downloads, mailing lists at

OpenNebula.org

The Open Source Toolkit for Cloud Computing

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)