Cloud Computing and its Applications
20th October 2009

OpenNebula
An Innovative Open Source Toolkit for Building Cloud Solutions

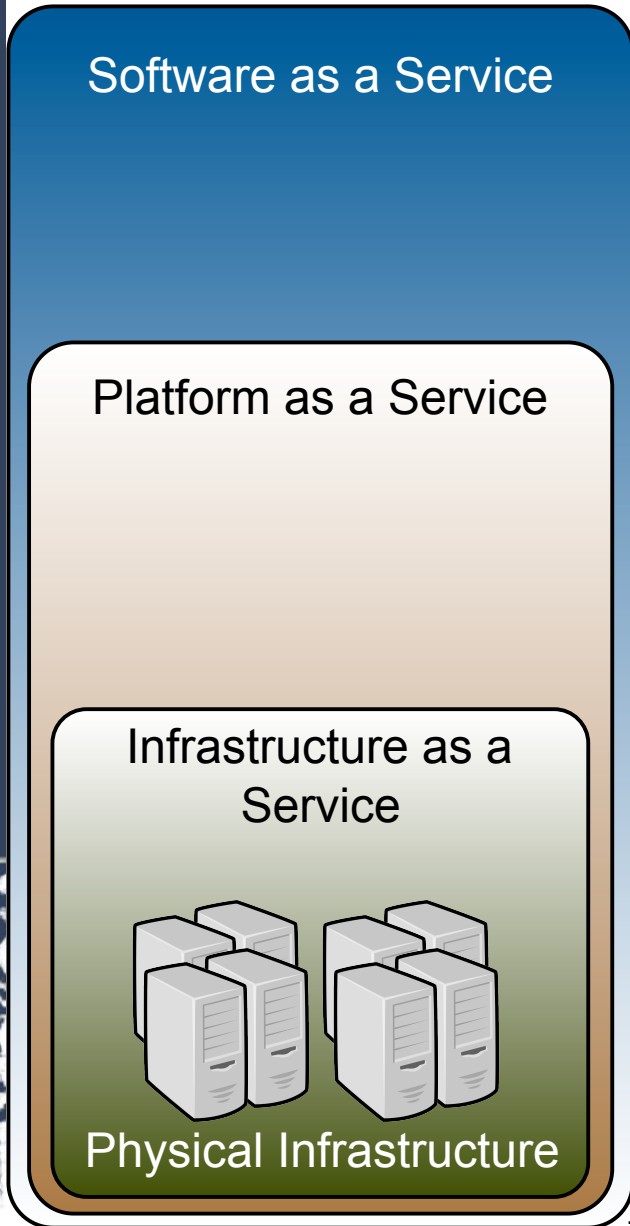**Ignacio M. Llorente**

dsa-research.org

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Position in the Cloud Ecosystem

OpenNebula - An Innovative Open Source Toolkit for Building Cloud Solutions

Contents

OpenNebula - An Innovative Open Source Toolkit for Building Cloud Solutions

RESERVOIR

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

OpenNebula.org

Toolkit
OpenNebula v1.4

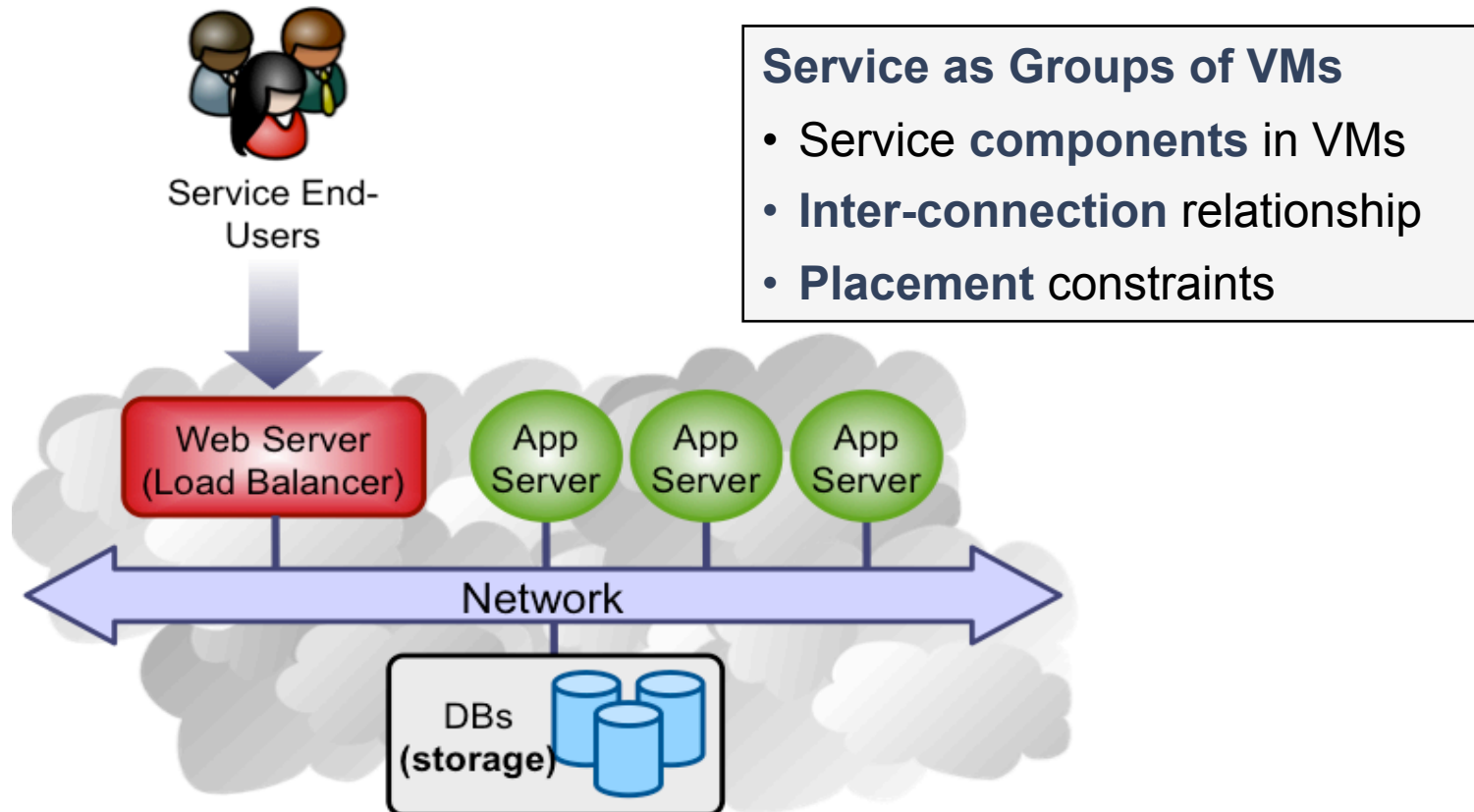**Community**
Users, projects and ecosystem

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

Service End-Users

Web Server (Load Balancer)

App Server App Server App Server

Network

DBs (storage)

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
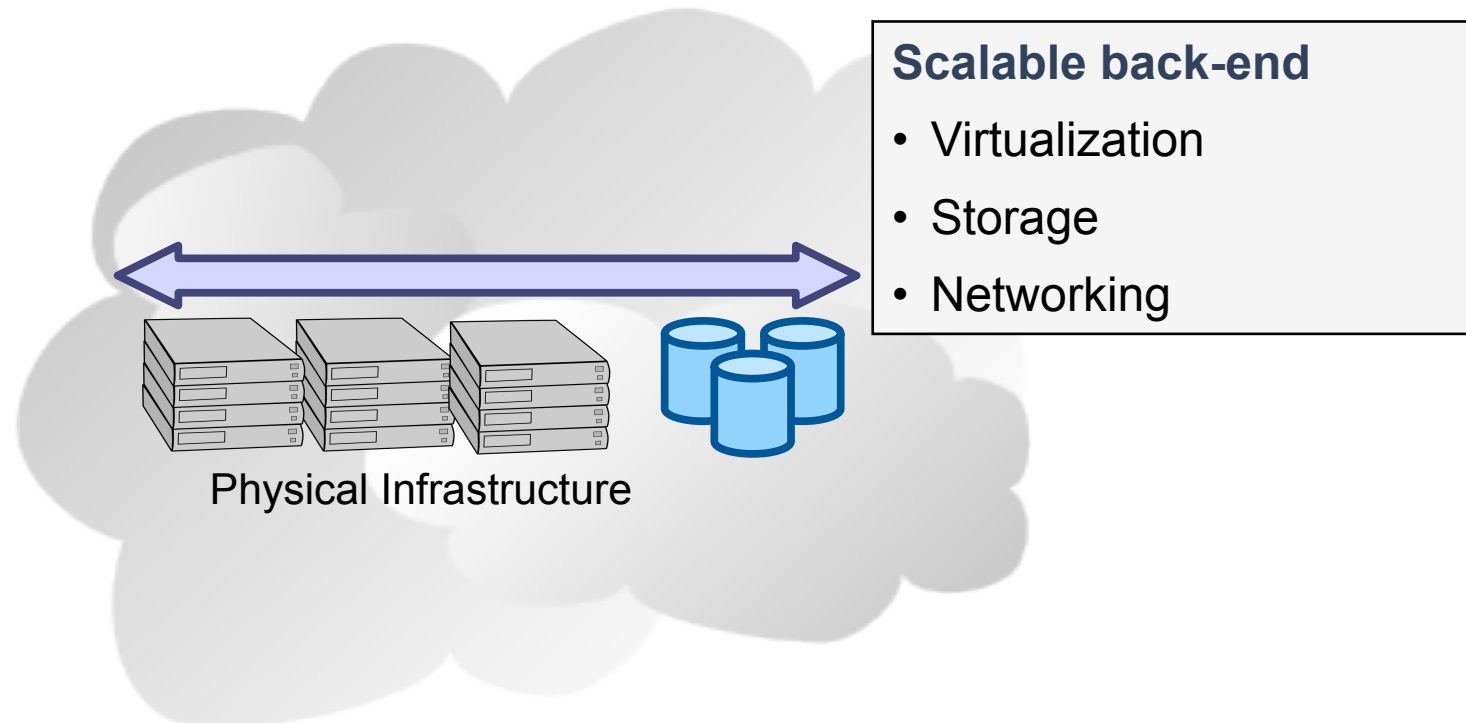
Scalable back-end

- Virtualization

- Storage

- Networking

Physical Infrastructure

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
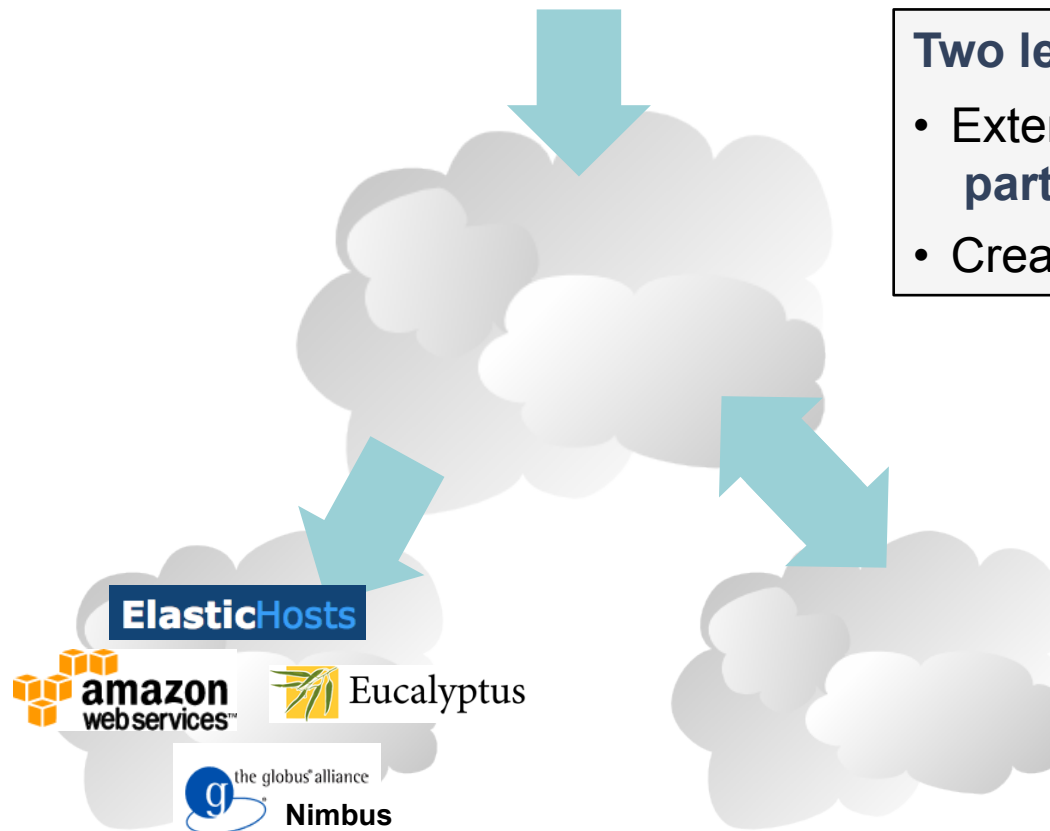
Two levels of Collaboration

- Extend the private cloud using both **partner and commercial clouds**
- Create a **federation of clouds**

ElasticHosts

amazon webservices™

Eucalyptus

the globus alliance
**Nimbus**

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**
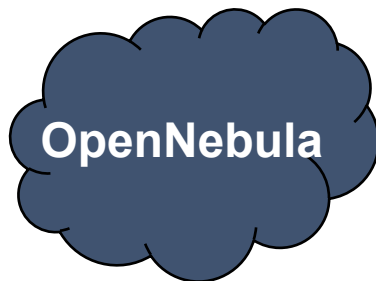
OpenNebula

Out-of-the-box
Cloud Solution
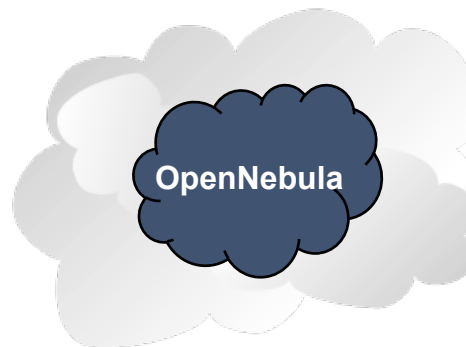
OpenNebula

Embedded VM
Orchestrator in PaaS
and SaaS Solution
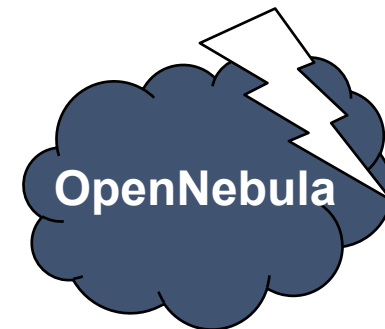
OpenNebula
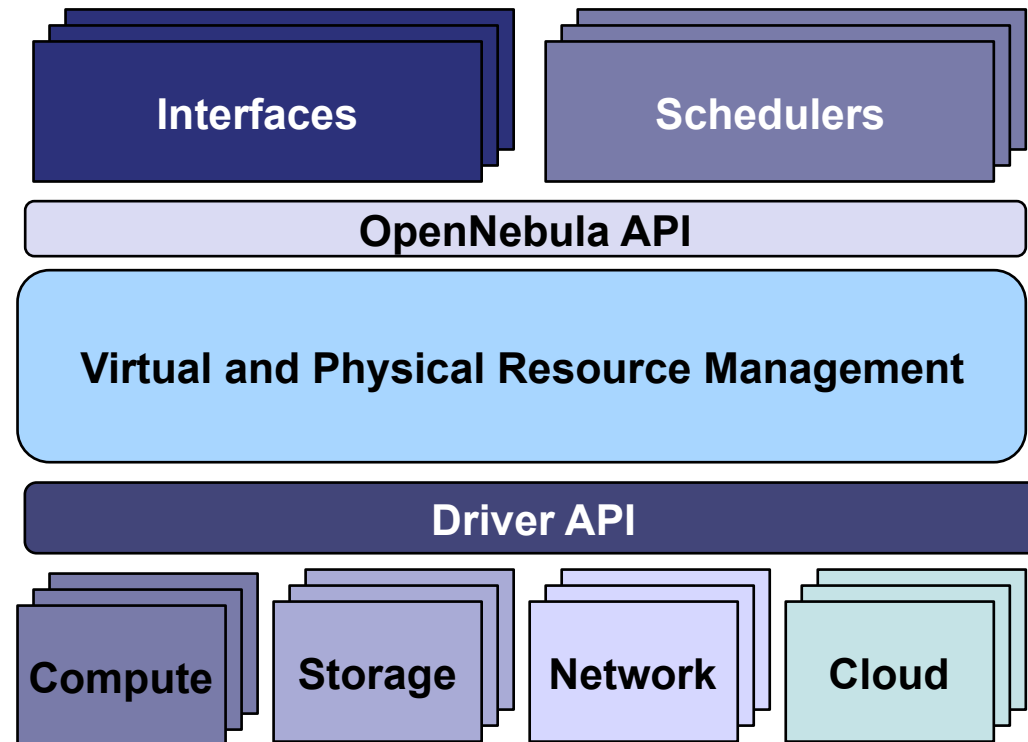
Platform for Innovative
Projects

The Toolkit: OpenNebula 1.4

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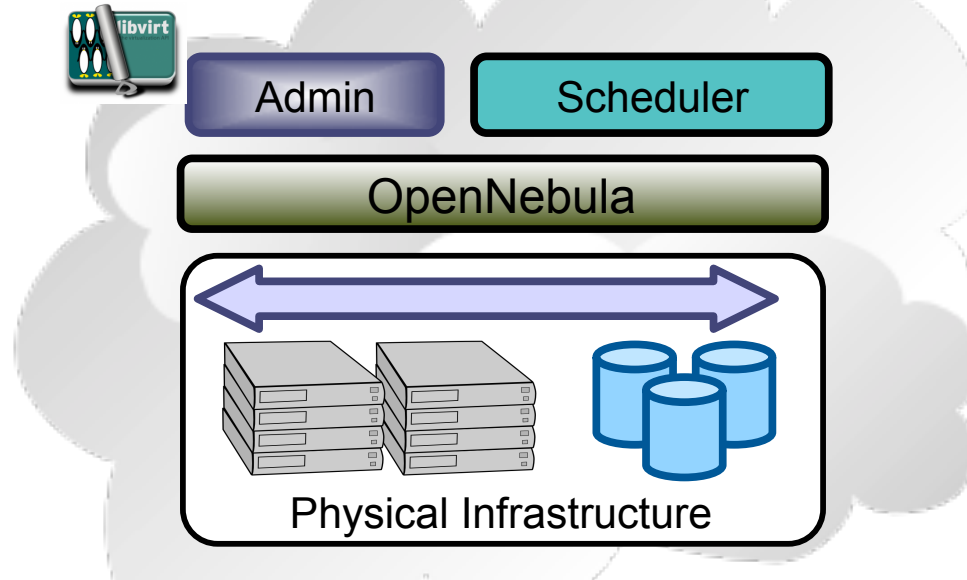
One Size does not Fit All: Tailoring the Tool to Fit your Needs

- Open, modular and extensible architecture
- Minimal installation requirements (distributed in Ubuntu)
- Open Source – Apache 2
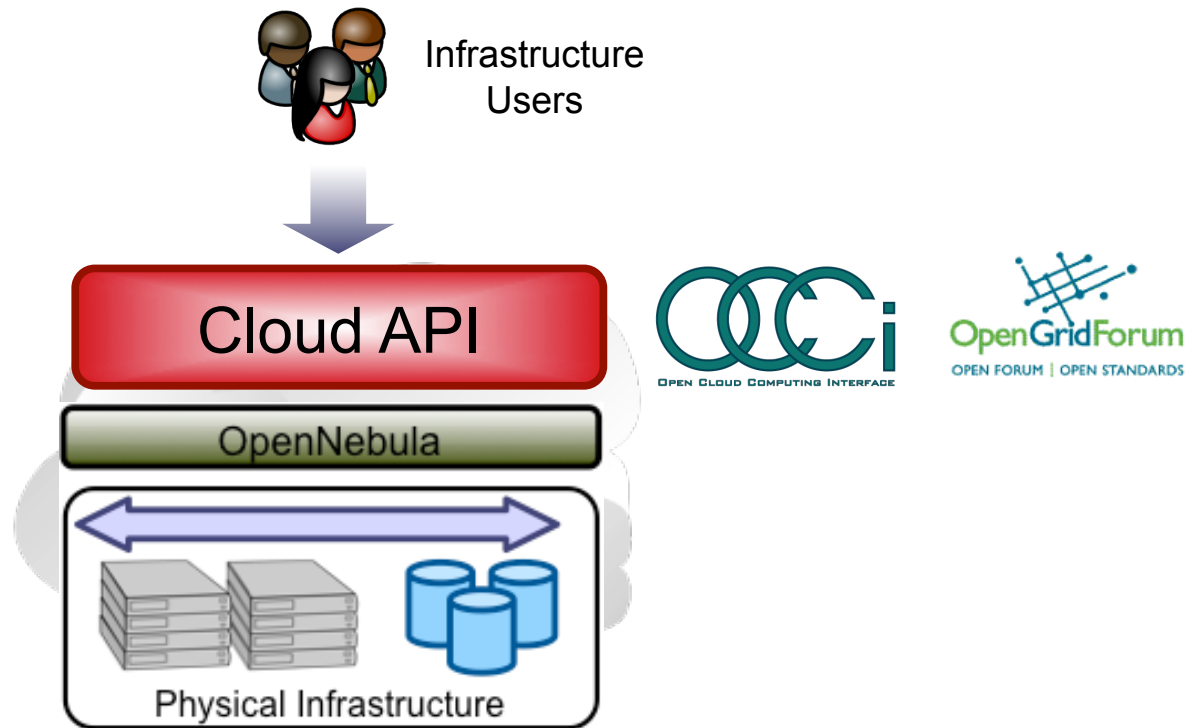
The Toolkit: Building a Private Cloud

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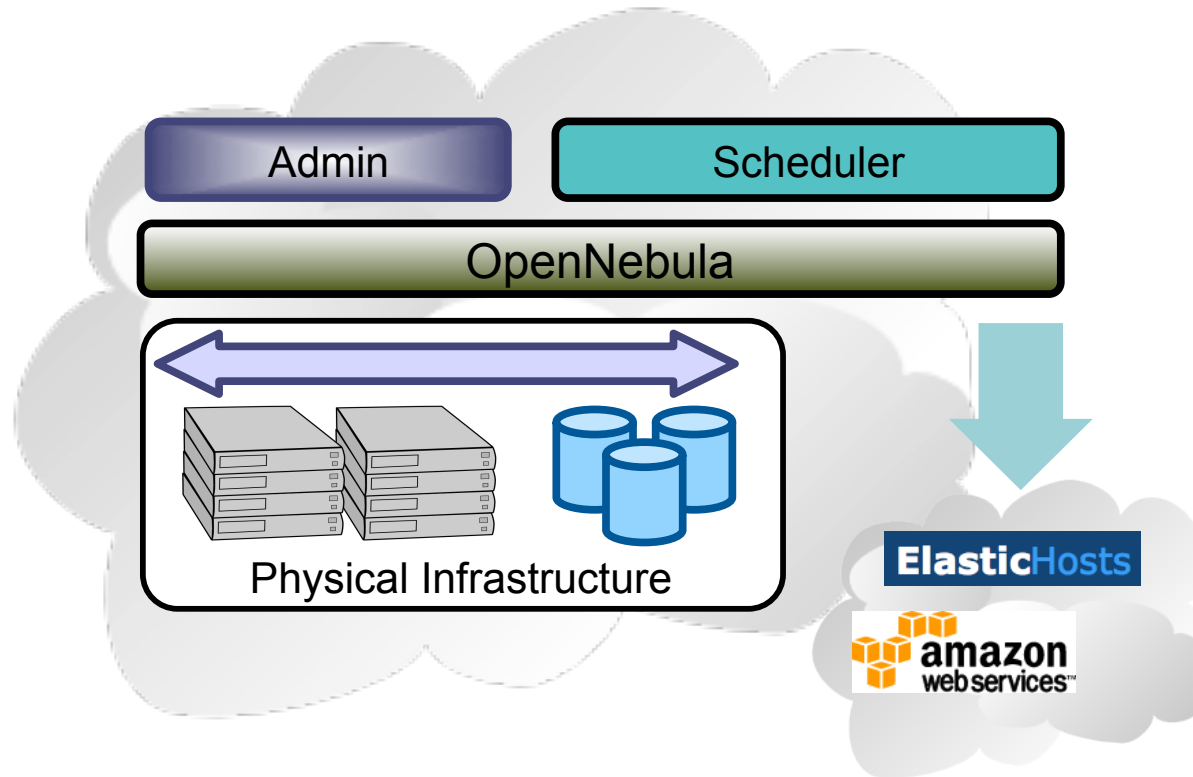| Feature	Function
Internal Interface	• Unix-like CLI for fully management of VM life-cycle and resources • XML-RPC API and libvirt virtualization API
Scheduler	• Requirement/rank matchmaker allowing the definition of workload and resource-aware allocation policies • Support for advance reservation of 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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Feature	Function
Cloud Interfaces for Users	• Implementation of a subset of the EC2 Query API and OGF - OCCI
Flexibility	• The Cloud Service allows the implementation of new Cloud interfaces

The Toolkit: Building a Hybrid Cloud

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| 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 and Projects

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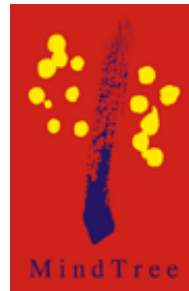
Projects

# 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
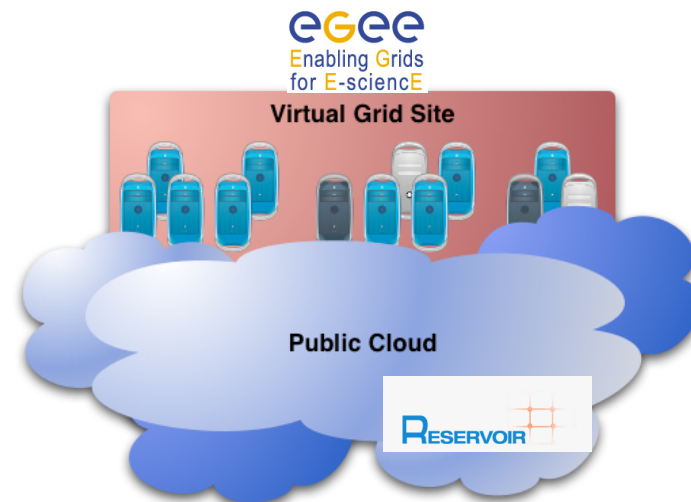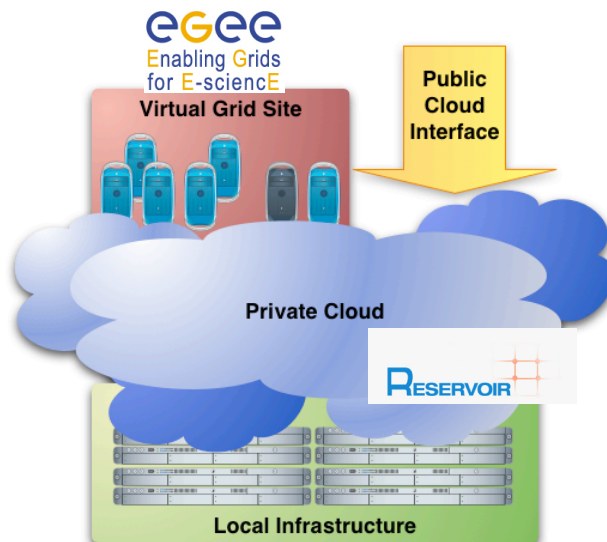
The Community: Active Ecosystem

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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,…

- …

The Community: Ecosystem

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Haizea Lease Manager

≋ HAIZEA   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)
- Open source (Apache 2)

An Innovative Open-source Toolkit for Cloud Computing

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

OpenNebula is partially funded by the "RESERVOIR– Resources and Services Virtualization without Barriers" project , **EU grant agreement 215605**

RESERVOIR
www.reservoir-fp7.eu/

References

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- 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

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