Cloud Computing Architecture with OpenNebula
HPC Cloud Use Cases

Ignacio M. Llorente
Project Director
OpenNebula.org

© OpenNebula Project. Creative Commons Attribution-NonCommercial-ShareAlike License
This presentation is about:

- Cloud case studies in HPC
- Private cloud computing using OpenNebula
- The anatomy of a Private Cloud
- OpenNebula innovative features for HPC
What is OpenNebula?
Open Cloud Solution for Building and Managing Virtualized Data Centers

Public

OpenNebula

Private

Hybrid
The HPC Cloud Use Case

The Pre-cloud Era

Access

Grid Middleware

Provision

LRMS (LSF, PBS, SGE...)

Cloud Computing Architecture with OpenNebula - HPC Cloud Use Cases
The HPC Cloud Use Case

OpenNebula as an Infrastructure Tool

Access
- Grid Middleware

Service
- LRMS (LSF, PBS, SGE...)
- Virtual Worker Nodes

Provision
- OpenNebula.org

Service/Provisioning Decoupling
- Common interfaces
- Grid integration
- Custom environments
- Dynamic elasticity

- Consolidation of WNs
- Simplified management
- Physical - Virtual WNs
- Dynamic capacity partitioning
- Faster upgrades
The HPC Cloud Use Case

OpenNebula as an Provisioning Tool

- **Simple Provisioning Interface**
- **Raw/Appliance VMs**

- **Dynamic scalable computing**
- **Custom access to capacity**
- **Not only batch workloads**
- **Not only scientific workloads**

- **Improve utilization**
- **Reduced service management**
- **Cost efficiency**
The HPC Cloud Use Case

Examples: CERN’s lxcloud

Goal
- Virtualized HTC Batch Nodes: limited life-time, dynamic capacity
- EC2 Query: CernVM

Deployment Notes
- Custom network integration MAC/IP pinning
- Fast image distribution & boot: BitTorrent + LVM snapshots
- OpenNebula tests up to 20,000 VMs (great feedback!)

http://blog.opennebula.org/?p=620
The HPC Cloud Use Case

Examples: FermiCloud

Goal

- Scientific stakeholders get access to on-demand VMs
- Developers & integrators of new Grid applications
- MPI and legacy applications

Deployment Notes

- VMs access Fermilab Networking and Storage Services
- OpenNebula + X509 support (contributed back!)
- Other areas: HA, Batch queues look-ahead, cluster on-demand...

http://www-fermicloud.fnal.gov/
The HPC Cloud Use Case

Examples: SARA

Goal

- HPC clusters on-demand: Self service, elastic and fully configurable HPC systems
- Offer production infrastructure for several engineering and scientific communities: Bioinformatics, ecology...

Deployment Notes

- Low latency network for HPC
- Extensions in accounting, GUI, firewallsing... (contributed back!)

https://www.cloud.sara.nl/
The HPC Cloud Use Case

One of Our Main User Communities

Supercomputing Centers

Research Centers

Distributed Computing Infrastructures
The Anatomy of the Cloud

Different Perspectives of the Cloud

Cloud User

Cloud Provider

Cloud Integrator

OpenNebula
Using the Cloud

How Can I Create and Manage my Virtual Infrastructure?

... standards (de facto and de jure) Cloud APIs to leverage existing ecosystems and ensure portability across providers, and self-service portal ....

1. Use AWS existing tools like ElasticFox
2. Execute complete computing cluster
3. Manage persistent scientific data
4. Catalog with pre-defined environments
5. Sharing between users or groups

- Manage images, networks and instances
Building the Cloud

What are the Main Components to Build a Cloud Infrastructure?

Instance Networks
- Guests
- Public and private networks

Front-end
- Authentication
- Authorization
- ACLs, roles, groups...
- Accounting
- Logging
- Resource quotas

Service Networks
- Monitoring, control...
- Live migration...
- Storage access...

Hosts
- Multiple hypervisors
- Up to 500 hosts
- Automatic failover and HA
- Automatic resource allocation

Datastores
- VM image storage
- Multiple datastores
- Heterogeneous configurations
- Shared or non-shared

Internet

- Fair share of resources
- Place VM close to data
Building the Cloud

Broad Commodity and Enterprise Platform Support

**Instance Network**
- VLAN per user (layer2)
- Open vSwitch, 802.1q
- Ebtables

**Front-end**
- X509, LDAP, ssh keys
- ACLs, roles, groups...

**Service Network**
- Ganglia/Nagios
- Additional monitor agents

**Hosts**
- VMware
- Xen
- KVM

**Datastores**
- NAS: NFS, Gluster, GlusterFS...
- SAN: Fibre Channel, iSCSI, LVM...
- DFS: Bit Torrent, ssh...
Innovative Features

Cluster the Physical Resources

Clusters

- Pools of hosts that share datastores and networks
- Group different configurations for performance and security

Multiple Datastores per Cluster

- Balance I/O operations between storage servers
- Define different SLA policies (e.g. backup) and performance features for different VM types or users

Different Hw for different workloads profiles (HPC vs HTC)

Isolation and security levels
Innovative Features

Centralized Management of Multiple OpenNebula Instances (Zones)

Cloud Consumer

- oZones Server
  - Portal
  - Cloud API (EC2, OCCI)
  - Global AuthN

- Full Isolation of performance-sensitive applications
- Isolation and security levels
- Multi-tier
- Scalability
- Multiple-site

OpenNebula

Full Isolation of performance-sensitive applications

Isolation and security levels

Multi-tier

Scalability

Multiple-site

OpenNebula
Innovative Features

On-demand Provision of Virtual Data Centers

- Provide VOs or Departments with their own isolated cloud compartment
- Associated to clusters with specific Hw and Sw profiles, or security levels
Innovative Features

Hybrid Cloud Computing

Hybrid
- Extension of the local private infrastructure with resources from remote clouds
- Cloudbursting to meet peak or fluctuating demands

Cloud User

OpenNebula

Cloud Provider

- HTC workloads
- Managed by the admin
Operating the Cloud

How Can I Operate my Cloud Infrastructure?

... programming APIs (create new tools and integrate), web interfaces (simplify operation), and command lined interface (create scripts)...

**Automatic/Elastic Management of Computing Service**

**API**
- XML-RPC
- OCA (Ruby, Java, Python)

CLI

OpenNebula Sunstone
Integrating the Cloud

The Ecosystem

... truly open (fully open-source, Apache license) and adaptable (modular and extensible)... because no two data centers are the same
OpenNebula.org

- Develop & innovate
- Support the community
- Collaborate

European Funding

Third party scalability tests: 16,000 VMs

Commercial Support

C12G

TP


的力量 group doing research...

ubuntu debian openSUSE fedora

4,000 downloads/month
About the OpenNebula Project

A Quickly Growing Community More than Doubling Each Year

**Downloads**
- 140% Annual Growth
- 900 downloads in the last week
- Linux distro and code repo

2008: 1,865
2009: 4,861
2010: 12,828
2011: 25,200

**Site Visits**
- 150% Annual Growth
- 15,300 visits and 194,000 page views in the last week

2008: 35,842
2009: 111,541
2010: 254,186
2011: 579,571

**Mails**
- 170% Annual Growth
- 800 registered users at present

2008: 227
2009: 1,141
2010: 2,293
2011: 4,341

Date: November 7th, 2011
About the OpenNebula Project

Open Cloud Enabler in the ICT Industry

Enabling Hosting Companies and Telcos to Offer Cloud Services

Enabling Technology Companies to Offer Cloud Products

Enabling Service Companies to Offer Cloud Consulting and Integration
About the OpenNebula Project

Open Cloud Enabler for Building and Research and Innovation

Distributed Computing Infrastructures

- egi
- PRAGA
- Future Grid
- BonFIRE
- megah

Research Projects

- RESERVOIR
- custom
- 4CaaSt
- Venus-C
- BiG Grid
- TClouds
- StratusLab
- contrail
- SAIL
- GAMES
Questions?

We Will Be Happy to Answer Any Question

Leading Cloud Management Solution

More than 4,000 Downloads per Month
Most Powerful Platform for Enterprise Data Center Innovation
Vendor-agnostic Open Alternative to Proprietary Cloud Solutions

OpenNebula is the open-source industry standard for data center virtualization, offering the most feature-rich, customizable solution for the comprehensive management of virtualized data centers based on VMware, Xen and KVM. OpenNebula interoperability makes cloud an evolution by leveraging existing IT assets, protecting your investments, and avoiding vendor lock-in.

Open
- Open-source (not open-core) software
- Fully open-source (not open-core) software

Adaptable
- Customizable to fit into your own data center
- Interoperable
- Most popular cloud APIs and standard-based

Proven
- Many massive scale production deployments
- Platform independent on major hypervisors

OpenNebula 3
- Advanced multi-tenancy
- Virtual data centers
- Multiple zones
- ... and many more things

Download now

Install OpenNebula from the Official Repo of your favourite Linux Distro.