New resource provision paradigms for Grid Infrastructures: Virtualization and Cloud

Ruben Santiago Montero
dsa-research.org
Distributed Systems Architecture Research Group
Universidad Complutense de Madrid
Objectives

- Brief review of some limitations of current Grids
- Use of virtual machines in Grids and its use for the dynamic provisioning of virtual clusters
- Grids & Clouds: Scale-out a Grid sites
- Demo!
"Any problem in computer science can be solved with another layer of indirection... But that usually will create another problem."

David Wheeler

A Grid... a new abstraction layer

“A (computational) Grid is an abstraction layer (middleware) to integrate disparate administration domains (platforms and policies)"

Common Interface for Each Type of Resources: User can access a wide set of resources.

Types of Resources: Computational, storage and network.
Brief Review of Grid Infrastructures

New provision models for Grids: Virtualization and Clouds

Some Limitations of Current Grids

• High degree of heterogeneity (software & hardware)
• High operational costs
• Isolate and partition resources contributed to the Grid
• Specific environment requirements for different VOs

Grids are difficult to maintain, operate and use
Virtual Machines

- A VM is an isolated runtime environment (guest OS and apps)
- Hypervisors: Full Virtualized, para-virtualization, HW Virtualization

### Benefits of Virtualization Platforms

- Natural way to deal with the *heterogeneity* of the infrastructure
- Allow partitioning and isolating of physical resources
- Execution of legacy applications
Virtual Infrastructure Manager (VIM)

- ...but something more is needed
  - Where did/do I put my VM? (*scheduling & monitoring*)
  - How do I provision a new cluster node? (*clone & context*)
  - What MAC addresses are available? (*networking*)
- Provides a *uniform view* of the resource pool
- *Life-cycle management* and monitoring of VM
- The VIM *integrates* Image, Network and Virtualization
The OpenNebula Virtual Infrastructure Manager

- Flexible & Open Design
- Third-party components
- Easily adapted & extended
- Management of Virtual Services
- Image, Network & Context
- Integrated with cloud providers
- Open Source – Apache2
- Included in Ubuntu 9.04 (server)

www.OpenNebula.org
A New Infrastructure Layer for Grids...

- Separation of Resource Provisioning from Job Management
- Seamless integration with the existing middleware stacks.
- Completely transparent to the computing service and end users

LRMS (Job Management)

Virtual cluster nodes

OpenNebula (VIM)

VMM

Physical Resource
Grids & Virtual Machines

New provision models for Grids: Virtualization and Clouds

Cluster users

Virtual Network

Virtual Infrastructure Manager

Physical Infrastructure

Infrastructure Layer

Service Layer

Cluster Front-end

Virtual Workernodes (WN)
Grids & Virtual Machines

New provision models for Grids: Virtualization and Clouds

Cluster users

- User Requests
  - "used-to" LRMS interface
  - Virtualization overhead

OpenNebula (VIM)

Infrastructure Layer

Physical Infrastructure

Virtual Network

Cluster Front-end

Virtual WNs
Grids & Virtual Machines

New provision models for Grids: Virtualization and Clouds

Cluster users

Virtual Network

Cluster Front-end

Virtual WNs

OpenNebula (VIM)

Service Layer

Infrastructure Layer

Cluster Consolidation
- Multiple clusters in a single cluster
- Dynamic provision rules
- Leverage VMM functionality

Physical Infrastructure
Grids & Virtual Machines

New provision models for Grids: Virtualization and Clouds

Cluster users

Service Layer

OpenNebula (VIM)

Infrastructure Layer

Cluster Partitioning
- Performance partitioning
- Isolate cluster workload
- Dedicated HA partitions

Dedicated WN | Physical Infr.
**Grids & Virtual Machines**

New provision models for Grids: Virtualization and Clouds

**Cluster users**

**Service Layer**

- Cluster Front-end
- Virtual WNs

**Physical Infrastructure**

- Heterogenous Workloads
  - Dynamic provision of cluster configurations
  - Simultaneous support of different services
  - E.g. on-demand VO workernodes in Grids

**Infrastructure Layer**

- Web Server
- HTTP clients

OpenNebula (VIM)
A Complete Grid Middleware Stack

New provision models for Grids: Virtualization and Clouds

- Unmodified Applications (Grid or local)
- Interfaces preserved (qsub, DRMAA..)

Applications

- Virtual resources are exposed by GM
- Dynamic scheduling
- Fault detection & recovery

Grid Middleware Layer

- WNs register to different queues
- Multiple VO-specific clusters

Computing Service Layer

- Infrastructure consolidation
- Infrastructure partitioning
- Infrastructure adaptation

Infrastructure Layer

- Meta-schedulers (GridWay, Condor/G...)
- gLite, UNICORE, Globus...
- Cluster Frontend (SGE...)
- OpenNebula (VIM)
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Cloud Computing, An Infrastructure View

New provision models for Grids: Virtualization and Clouds

A Service to Provide Hardware on Demand (IaaS)

- Cloud systems provide virtualized resources as a service
- Provide remote on-demand access to infrastructure (through VMs)

- Simple Web interface (REST)
- Virtualization
- Pay-as-you-go
- Elastic & “infinite” capacity

Infrastructure Cloud Services

- Commercial Cloud Providers: Amazon EC2, GoGrid, Elastic Hosts...
- Open Source Cloud: Nimbus, Eucalyptus
Cloud Computing, An Infrastructure View

New provision models for Grids: Virtualization and Clouds

Cluster users

Service Layer

Virtual Network

Cluster Front-end

Virtual Workernodes

OpenNebula (Virtual Infrastructure Manager)

Local Physical Infrastructure

Cloud Provider

Infrastructure Layer
Cloud Computing, An Infrastructure View

New provision models for Grids: Virtualization and Clouds

Amazon EC2

Internet Connection

OpenVPN Tunnels

OpenVPN Server

SGE Front-End

Physical Host

Local private network

Bridge

Worker Node

Worker Node

Physical Host

Bridge

Worker Node

Worker Node

Physical Host

Bridge

Worker Node

Physical Host

Bridge

Worker Node

Worker Node

Physical Host
Summary & Conclusions

The Infrastructure Quadrant

How are the resources provisioned?

Where are the resources provisioned from?

GRID

PRIVATE CLOUD

YOUR SITE

Physical

Virtual

Remote

Local
Conclusions

New provision models for Grids: Virtualization and Clouds

About the Coexistence of Grid and Clouds

• Virtualization, cloud, and grid are complementary technologies and will coexist and cooperate at different levels of abstraction

• Virtualization can solve many obstacles for Grid adoption

• Virtualization and cloud do NOT require any modification within service layers from both the administrator and the end-user perspectives

• Separation between service and infrastructure layers will allow the application of the utility model to Grid/cluster/HPC computing
Thanks and More Info

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

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www.reservoir-fp7.eu/

The OpenNebula Team

• Ignacio M. Llorente (llorente@dacya.ucm.es)
• Ruben S. Montero (rubensm@dacya.ucm.es)
• Rafel Moreno (rmoreno@dacya.ucm.es)
• Tino Vazquez (tinova@fdi.ucm.es)
• Javier Fontan (jfontan@fdi.ucm.es)
THANK YOU FOR YOUR ATTENTION

QUESTIONS?