An Introduction to Virtualization and Cloud Technologies to Support Grid Computing

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Objectives

An Introduction to Virtualization and Cloud Technologies to Support Grid Computing

- Introduce virtualization and cloud from the perspective of the Grid community
- Show the benefits of virtualization and cloud for Grid computing
- Demonstrate how Grid, virtualization and cloud are complementary technologies that will cooperate in future Grid computing infrastructures
- Introduce the RESERVOIR project, European initiative in virtualization and cloud computing
Barriers for Adoption of the Compute Grid Model

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• High degree of heterogeneity (software & hardware)

• High operational costs

• Isolate and partition amount of resources contributed to the Grid

• Specific environment requirements for different VOs

Grids are difficult to maintain, operate and use
Virtualization Platform

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Separation of Virtual Machine from Physical Infrastructure

- A VM is an isolated runtime environment (guest OS and applications)
- Multiple virtual systems (VMs) to run on a single physical system

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
Distributed Management of VMs

Extending the Benefits of Virtualization to a Physical Cluster

- VM Managers creates a distributed virtualization layer
  - Extend the benefits of VM Monitors from one to multiple resources
  - Decouple the VM (service) from the physical location
- Transform a distributed physical infrastructure into a **flexible and elastic virtual infrastructure**

Benefits of VM Managers

- Centralized management
- Balance of workload
- Server consolidation
- Dynamic resizing of the infrastructure
- Dynamic cluster partitioning
- Support for heterogeneous workloads
- On-demand provision of VMs
Virtualization of a Computing Cluster

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Separation of Resource Provisioning from Job Management

- New virtualization layer **between the service and the infrastructure layers**
- **Seamless integration** with the existing middleware stacks.
- ** Completely transparent** to the computing service and so end users
Integration of a Virtualized Cluster within a Grid

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- Grid Applications
- Grid interfaces (DRMAA...)

Applications

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

Grid Middleware

- Local computing resources

Local Computing Infrastructure

- Grid and central services virtualization
- Coexist with other services

Physical Infrastructure Layer

- VMM
- VMM
- VMM

Cluster Frontend (SGE)

- MDS
- GRAM
- GridFTP

OpenNebula

- Local computing resources

GridWay

- Virtual resources are exposed by GT
Integration of a Virtualized Cluster within a Grid

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Benefits of Virtualization for Existing Grid Infrastructures

- The virtualization of the local infrastructure provides:
  - Easy support for VO-specific worker nodes
  - Reduce gridification cycles
  - Dynamic balance of resources between VO’s
  - Fault tolerance of key infrastructure components
  - Easier deployment and testing of new middleware distributions
  - Distribution of pre-configured components
  - Cheaper development nodes
  - Simplified training machines deployment
  - Performance partitioning between local and grid services

Solve many of the obstacles for Grid adoption
Cloud as Provision of Virtualized Resources

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A Service to Provide Hardware on Demand (IaaS)

- Cloud systems provide virtualized resources as a service
- Provide remote on-demand access to infrastructure for the execution of virtual machines

Simple Interfaces for VM Management

- Submission
- Control
- Monitoring

- Main components of a Cloud architecture:
  - Front-end: Remote interface (Eucalyptus, Globus Nimbus…)
  - Back-end: Local VM manager (OpenNebula)

Infrastructure Cloud Services

- Commercial Cloud: Amazon EC2, GoGrid, Flexiscale…
- Scientific Cloud: Nimbus (University of Chicago)
On-demand Access to Cloud Resources

- Supplement local resources with cloud resources to **satisfy peak or fluctuating demands**
RESERVOIR Project

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Who?

• IBM (coordinator), Sun, SAP, ED, TID, UCM, UNIME, UMEA, UCL, USI, CETIC, Thales and OGF-Europe

• 17-million and 3-year project partially funded by the European Commission (NESSI Strategic Project)

What?

• The Next Generation Infrastructure for Service Delivery, where resources and services can be transparently and dynamically managed, provisioned and relocated like utilities – virtually “without borders”

How?

• Integration of virtualization technologies with grid computing driven by new techniques for business service management, driven by business use cases

=SOI
The Architecture, main Components and Interfaces

Monitor service and enforce SLA compliance by managing number and capacity of service components (VEEs)

Organize the placement of VEEs to meet optimization policies and constraints

Support advanced new functionality for performance and relocation optimization

Service Provider

Service Manager System (SMS)

VEE Management System (VEEMS)

VEE Host (VEEH) (e.g., Hypervisor, VJSC Host)

Reservoir Infrastructure Provider (RIP)
Conclusions

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About the Coexistence of Grid, Virtualization and Clouds

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

• 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
THANK YOU FOR YOUR ATTENTION!!!
More info, downloads, mailing lists at
www.OpenNebula.org

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www.reservoir-fp7.eu/

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Demo on Scaling-out Local Infrastructures

Cluster Users

Service Layer

Cloud Provider
Amazon EC2

Infrastructure Layer

Virtual Cluster

Local Infrastructure

VEEM

Capacity Manager

VEEM Core

XEN / KVM Drivers

EC2 Driver

Cluster Users

Virtual Cluster