Virtual Machine Management with OpenNebula in the RESERVOIR project

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Objectives

- Describe the goals of the RESERVOIR project and provide an overview of its architecture and design principles
- Discuss the challenges of managing VMs in a distributed environment and present the VM management model adopted by OpenNebula
- Study the operation of a Distributed VM Manager in clouds environments
- A simple use case: Elastic Management of Computing Clusters
RESERVOIR

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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

Virtualization - Aware Grid
e.g., VM as management unit for metering and billing

Grid - Aware Virtualization
e.g., live migration across administrative domains

BSM
e.g., policy based manag. of service -level agreement

= SOI
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The Architecture, main Components and Interfaces

- Service Provider
- Service Manager
- VEE Host
- VEE Manager
- Monitor service and enforce SLA compliance by managing number and capacity of service components (VEE)

Service Users
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The Architecture, main Components and Interfaces

- Service Provider
- Service Manager
- VEE Manager
- VEE Host

Organize the placement of VEEs to meet optimization policies and constraints

Support advance functionality for performance and reallocation optimization
Distributed Management of Virtual Machines

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Virtual Machine Model

- The **service** as a first-class management entity
- Service **structure**
  - Service components run in VMs
  - Inter-connection relationship
  - Placement constraints
- The VM Manager is **service agnostic**
- However, it should provide **infrastructure context**
Distributed Management of Virtual Machines

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Distributed Virtual Machine Management System

• Provides a uniform view of the resource pool
• Resources organized in a cluster architecture
• *Life-cycle management* and monitoring of VM
• The VM Management System *integrates* Image, Network and Virtualization technologies

The *three pillars* of a Distributed VM Manager
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Image Management

• VM Images Sources:
  • Master images in local repositories
  • Appliance supplier
  • Creation on the fly

• Clones have to be contextualized (Context VBD)
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Network Management

• VMs interconnected through **one or more** networks
  • Isolated, layer 2 LANs
  • Virtual networks are dynamically created
  • Medium size networks (x.x.x.x/20) with limited public IPs
• TCP/IP services are not responsibility of the VM Manager

Sample Implementation
Distributed Management of Virtual Machines

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Virtualization

- Virtual Machine structure
  - One or more NICs attached to virtual or public networks
  - One or more system images (clones)
  - A context virtual block device
  - A *required capacity (memory, CPU)*
- Use the host hypervisor to create, monitor and control VMs
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Life-cycle of a Virtual Machine (or a set of)

• **Resource Selection:** *Where do I place the VM?*
  - Capacity planning (consolidation)
  - Placement requirements (e.g. affinity)
  - Placement Heuristics (e.g. Green IT, AR...)

• **Resource Preparation:** *What do I need for the VM?*
  - Network preparation
  - Image cloning & contextualization

• **VM Creation:** *How do I start a VM?*
  - Interface with different hypervisors

• **VM Monitoring:** *How is the VM doing?*

• **VM Migration:** *Is there a better resource for the VM?*
  - Adjust placement to better fit to the infrastructure target

• **VM Termination:** *Do I need to save any VM image?*
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OpenNebula: Distributed VM Management System

- **Open Source** - Apache 2
- **Flexible & Open** Design
  - Third-party components
  - Easily adapted
  - Easily extended
- **Different Hypervisors**
- **Operation in Federated Environments**
- **Integral management** of Virtual Services
OpenNebula: Distributed VM Management System

• Manage IP and MAC addresses
  • Manage VM life-cycle
  • Manage Image transfers
  • Manage Physical Resources
  • Persistent back-end
OpenNebula: Distributed VM Management System

- Image management systems
- Physical resources
- Different hypervisors
  - Xen
  - KVM
  - Libvirt
  - EC2
  - VMware (planned)
OpenNebula: Distributed VM Management System

- VM placement policies & heuristics
- Plug-in module
- Available schedulers
  - Simple match-making scheduler

OpenNebula:
- Distributed VM Management System
- OpenNebula core
- Information Manager
- Image Manager
- VM Manager
- Network Manager
- Host, Net & VM Pools

OpenNebula API
- Access Drivers
- XEN, KVM, EC2, libvirt

SQLite Persistent Database

Scheduler

CLI

libvirt

Distributed Management of Virtual Machines
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OpenNebula: Distributed VM Management System

- Unix-like CLI
- Libvirt interface, integration with:
  - Virsh
  - Virt-manager
  - Other managers (e.g. Ovirt)
  - ...

OpenNebula core
- Information Manager
- Image Manager
- Host, Net & VM Pools

OpenNebula API
- XML-RPC
- Access Drivers
- XEN, KVM, EC2, libvirt

Scheduler

Persistent Database

sqlite
Elastic Management of Computing Clusters

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A New Infrastructure Layer...

- 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)

Distributed VM Manager

Virtual cluster nodes

Physical Resource
Elastic Management of Computing Clusters

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Cluster users

HTTP clients

Virtual Network

Cluster Front-end

Virtual Workernodes

Web Server

Service Layer

OpenNebula

Infrastructure Layer

Physical Infrastructure
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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 (through VMs)
- Main components of a **Cloud architecture**:
  - **Front-end**: Remote interface
  - **Back-end**: Local VM, image & network management

**Simple Interfaces**

- VM Management
- Image Management

**Infrastructure Cloud Services**

- **Commercial Cloud**: Amazon EC2, GoGrid…
- **Scientific Cloud**: Nimbus (University of Chicago)
Elastic Management of Computing Clusters

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Cluster users

Service Layer

Cluster Front-end

Virtual Network

Virtual Workernodes

OpenNebula

Local Physical Infrastructure

Infrastructure Layer

Cloud Provider
Federation of Cloud Sites

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- Consumer/Provider Relationships
- Nimbus integration (WSRF + EC2)
- RESERVOIR Cloud VMI
- Eucalyptus (planned)

- Federation of Cloud Providers
- Image, Network and VM issues
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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