Towards an Architecture for Monitoring Private Cloud

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1. ABSTRACT

This presentation describes:
- our experience with a private cloud;
- the design and implementation of a Private Cloud MONitoring System (PCMONS); and
- its application via a case study for the proposed architecture, using open source solutions and integrating with traditional tools like Nagios.
2. INTRODUCTION

- Cloud computing provides several technical benefits including flexible hardware and software allocation, elasticity, and performance isolation.

- Cloud management may be viewed as a specialization of distributed computing management, inheriting techniques from traditional computer network management.
The intent of this presentation is to:

- Provide insight into how traditional tools and methods for managing network and distributed systems can be reused in cloud computing management.

- Introduce a Private Cloud MONitoring System (PCMONS) we developed to validate this architecture, which we intend to open source.
2. INTRODUCTION

- Help future adopters of cloud computing make good decisions on building their monitoring system in the cloud.

- We chose to address private clouds because they enable enterprises to reap cloud benefits while keeping their mission-critical data and software under their control and under the governance of their security policies.
3. BACKGROUND

3.1. Cloud Computing Service Models

- **Software-as-a-Service (SaaS):** The consumer uses the provider’s applications, which are hosted in the cloud.

- **Platform-as-a-Service (PaaS):** Consumers deploy their own applications into the cloud infrastructure. Programming languages and applications development tools used must be supported by the provider.
3. BACKGROUND

3.1. Cloud Computing Service Models

- **Infrastructure-as-a-Service (IaaS):** Consumers are able to provision storage, network, processing, and other resources, and deploy and operate arbitrary software, ranging from applications to operating systems.

- This presentation focuses on IaaS model.
3. BACKGROUND

3.2. Cloud Computing Deployment Models

- **Public:** Resources are available to the general public over the Internet. In this case, “public” characterizes the scope of interface accessibility.

- **Private:** Resources are accessible within a private organization. This environment emphasizes the benefits of hardware investments.
3.2. Cloud Computing Deployment Models

- **Community**: Resources on this model are shared by several organizations with a common mission.

- **Hybrid**: This model mixes the techniques from public and private clouds. A private cloud can have its local infrastructure supplemented by computer capacity from public cloud.
3. BACKGROUND

3.3. Cloud Computing Standards

- **Open Cloud Computing Interface**: This Open Grid Forum group has a focus on specifications for interfacing “*aaS” cloud computing facilities.

- OCCI in Eucalyptus, OCCI in OpenStack, OCCI in OpenNebula...
3. BACKGROUND

3.3. Cloud Computing Standards

- **Open Cloud Standards Incubator**: This initiative, from Distributed Management Task Force (DMTF), focuses on interactions between cloud environments, their consumers, and developers.

- Example of document: “Use cases and Interactions for Managing Clouds”.
4. MONITORING ARCHITECTURE AND PCMONS

Private Cloud Monitoring System Architecture

View Layer

Nagios®

Business Manager

Network Administrator

Integration Layer

Cluster Data Integrator

Node Information Gatherer

Configuration Generator

Infrastructure Layer

Xen

OpenNebula.org

KVM

Eucalyptus
4. MONITORING ARCHITECTURE AND PCMONS

4.1. Architecture

- Three layers address the monitoring needs of a private cloud.
- **Infrastructure layer:**
  - Basic facilities, services, and installations, such as hardware and networks;
  - Available software: operating system, applications, licenses, hypervisors, and so on...
4. MONITORING ARCHITECTURE AND PCMONS

4.1. Architecture

- Integration layer:
  - The monitoring actions to be performed in the infrastructure layer must be systematized before passed to the appropriate service running in the integration layer.
  - The integration layer is responsible for abstracting any infrastructure details.
4. MONITORING ARCHITECTURE AND PCMONS

4.1. Architecture

- View layer:
  - This layer presents as the monitoring interface through which information, such as the fulfillment of organizational policies and service level agreements, can be analyzed.
  - Users of this layer are mainly interested in checking VM images and available service levels.
4. MONITORING ARCHITECTURE AND PCM Mons

4.2. Implementation

- The current PCM Mons version acts principally on the integration layer, by retrieving, gathering, and preparing relevant information for the visualization layer.

- The system is divided into the modules presented in the next figure and described below.
A typical deployment scenario for PCMONS
4. MONITORING ARCHITECTURE AND PCMONS

4.2 Implementation

- **Node Information Gatherer:** This module is responsible for gathering local information on a cloud node. It gathers information about local VMs and sends it to the Cluster Data Integrator.

- **Cluster Data Integrator:** It is a specific agent that gathers and prepares the data for the next level.
4. MONITORING ARCHITECTURE AND PCMONS

4.2 Implementation

- **Monitoring Data Integrator**: Gathers and stores cloud data in the database for historical purposes, and provides such data to the Configuration Generator.

- **VM Monitor**: This module injects scripts into the VMs that send useful data from the VM to the monitoring system.
4. MONITORING ARCHITECTURE AND PCMONGS

4.2 Implementation

- **Configuration Generator:** Retrieves information from the database to generate configuration files for visualization tools.

- **Monitoring Tool Server:** Its purpose is to receive monitoring information and take actions such as storing it in the database module for historical purposes.
4.2 Implementation

- **User Interface:** Most monitoring tools have their own user interface. Specific ones can be developed depending on needs, but in our case the Nagios interface is sufficient.

- **Database:** Stores data needed by Configuration Generator and the Monitoring Data Integrator.
5. CASE STUDY

- We built an environment where VM images are available for users that instantiate a web server, thus simulating web hosting service provision.

- Instantiated VMs are Linux servers providing a basic set of tools, acting as web hosting servers.

- Apache Web Server, PHP language, SQLite.
Testbed environment

LRG-UFSC

User
EC2 API

Cluster 01
Cloud controller
Cluster controller
Storage controller
node

Node

Node
5. CASE STUDY

- Open SUSE was chosen as the operating system of the physical machines (Xen and YaST).

- Eucalyptus (interface compatible with Amazon’s EC2). VM images were downloaded from the Eucalyptus website.

- VM Monitor module is injected into the VM during boot, allowing data monitoring.
Representative Nagios interface of the monitored cloud services

![Diagram showing service status and overview for monitored cloud services](image-url)
5. CASE STUDY

- First column shows object names (VM, PM, ROUTERS...). VM names are an aggregation of user name, VM ID, and name of PM where the VM is running.

- The other two columns show service names and their status (OK, Warning, Critical).

- It shows host group created by PCMONS and VM/VP mapping.
6. RELATED WORK

6.1. Grid Monitoring

- Several design issues that should be considered when constructing a Grid Monitoring System (GMS) are presented in [8]. We have selected some and correlated them with PCMOMS.
6. RELATED WORK

6.1. Grid Monitoring

- Reference [9] identifies some differences between cloud monitoring and grid monitoring, especially in terms of interfaces and service provisioning.

- Another difference is that clouds are managed by single entities [10], whereas grids may not have any central management entity.
6. RELATED WORK

6.2. Cloud Monitoring


- PCMONS supports two approaches, agents and central monitoring, and is highly adaptable, making the migration to a private cloud straightforward.
7. KEY LESSONS LEARNED

7.1. Related to Test-Bed Preparation

- Software platforms for cloud computing, such as Eucalyptus and OpenNebula, support a number of different hypervisors, each with its own characteristics.

- An example is the KVM hypervisor: it has great performance but requires hardware virtualization that not all processors provide.
7. KEY LESSONS LEARNED

7.2. Design and Implementation

- We opted for solutions well established in the market to facilitate the use of PCMONS in the running structures with little effort and prioritized an adaptable and extensible solution.

- We planned to define some basic common metrics for private clouds, but later found that metrics are often specific to each case.
7. KEY LESSONS LEARNED

7.3. Standardization and Available Implementations

- Before choosing a specific tool for private clouds, it is important to verify to what extent cloud standards are implemented by the tool.

- Some tools, such as OpenNebula, have begun implementing standardization efforts, including the OCCI API.
8. CONCLUSION AND FUTURE WORK

- This presentation summarizes some cloud computing concepts and our personal experience with this new paradigm.

- The current portfolio of open tools lacks open source, interoperable management and monitoring tools. To address this critical gap, we designed a monitoring architecture, and validated the architecture by developing PCMONS.
8. CONCLUSION AND FUTURE WORK

- To monitor specific metrics, especially in an interface-independent manner, a set of preconfigured monitoring plug-ins must be developed.

- For future work, we intend to improve PCMONS to monitor other metrics and support other open source tools like OpenNebula, OpenStack...
9. REFERENCES

References indicated in this presentation:


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