Proposal for a Cloud Computing solution and application in a pedagogical virtual organization

Amadou Dahirou Gueye¹, Ibrahima Sanogo², Samuel Ouya³, Hamadou Saliah-Hassane⁴ and Claude Lishou⁵

¹University Alioune Diop, Bambey, Senegal, dahirou.gueye@uadb.edu.sn
²University Cheikh Anta Diop, Dakar, Senegal, ibrahima124@gmail.com
³University Cheikh Anta Diop, Dakar, Senegal, samuel.ouya@gmail.com
⁴TELUQ |University of Quebec, Montreal, Canada, hamadou.saliah-hassane@teluq.ca
⁵University Cheikh Anta Diop, Dakar, Senegal, clishou@ucid.sn

Abstract

This paper considers a particular case of virtual organization composed of the following entities: institutions, online laboratories wishing to collaborate to share hardware and software resources. In the literature, cloud computing represents an implementation of the virtual organizations as grid computing. However, the benefits of the cloud are not used to the full in virtual organizations. This paper shows that it is possible to form a virtual organization around an IaaS cloud to enable member organizations of virtual organization to obtain supplies of resources on demand. Scarce resources shared by member organizations are also in the cloud. For this, we proposed two models of sharing resources: the centralized model for resources accessible via web and the decentralized model for physical resources not accessible via web. We used OpenStack platform to implement our solution.

Keywords: Cloud Computing, Infrastructure as a Service (IaaS), Virtual Organization, Online Laboratories, Shared Resources.

1. Introduction

Nowadays, Cloud Computing [1] has laid the ground for a new generation of educational systems, by providing scalable anytime/anywhere services simply accessed through the Web from multiple devices without worrying how/where those services are installed, maintained or located. However, the cloud, in addition to ready services for use, always the community to develop its own cloud infrastructure with IaaS (Infrastructure as a Service). A cloud infrastructure basically represents the set of software and hardware resources that are necessary for establishing the cloud. [2] To address the difficulty relating to lack of infrastructures in universities and labs in developing countries and also the difficulty in providing universal service, this paper propose to implement a virtual organization based on a cloud computing IaaS in order to facilitate sharing and optimizing resources. The remainder of this paper is organized as follows: section 2 introduces the related work. In section 3, we describe the relevance of using clouds in virtual organizations. In section 4, we propose two models of sharing resources based on the Cloud. To consolidate the proposed models, we implement, in section 5, a cloud computing solution based on IaaS (Infrastructure as a Service), constituting the core of our virtual organization. This solution is based on the centralized model. Finally, we conclude the whole paper in section 6.
2. Related work

2.1. Cloud Computing

The operational definition as retained by the NIST (National Institute of Standards and Technology) is as follows: “Cloud Computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”. [3] This cloud model is composed of five essential characteristics, three service models (SaaS (Service as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service)), and four deployment models (Private Cloud, Community Cloud, Public Cloud and Hybrid Cloud).

Another definition of cloud computing is given in [4] by Cisco, the networks global leader: “Computer science resources and services that are abstracted from the underlying infrastructure and provided “On demand” and “at scale” in a multitenant environment”.

- “On-demand” means that resources can be provisioned immediately when needed, released, when no longer required, and billed only when used.
- “At-scale” means the service provides the illusion of infinite resource availability in order to meet whatever demands are made of it.
- “Multitenant environment” means that the resources are provided to many consumers from a single implementation, saving the provider significant costs.

Cloud computing use technologies such as hardware virtualization, grids, service oriented architecture, and web services.

Simple state, a cloud is composed of the following elements: clients, data centers, and distributed servers. [5]

The main features of cloud computing are as follows: services on demand (self-service resources), measured services and payment after usage, a high broadband, shared data, elasticity and flexibility of resources. [4]

2.2. Virtual Organization (VO)

The notion of a "virtual organization” in a business context was first introduced by Mowshowitz [6] who used the term virtual enterprise (VE) to construct parallels between the virtual memory as is used in information technology (IT) and a VE. In the literature, there are several definitions of virtual organization (VO). [7] [8] It is based on the usage of information technologies, on organization's geographic position, on the organization’s multidisciplinary and dynamic character. To this end, a VO can be seen as a project-based alliance of enterprises that collaborate to achieve a specific goal. [9]

In this paper, we are targeting a particular type of virtual organization composed of individuals, institutions, labs or bodies which have all agreed to work together, through computer science networks, to achieve the objectives of sharing and optimizing resources of institutions of graduate studies in developing countries.

In Figure 1, authors demonstrated the validity of remote laboratories in Electrical Engineering [10], an approach that as since made its way into numerous educational institutions and research.
The goal was to create a positive learning environment that allows learners to access equipment in teaching labs using software interface for manipulating real devices via the web. Since most resources are accessible via web, integration of clouds in virtual organizations is essential to facilitate resources access and sharing of labs. [10] [11]

3. Benefits of the cloud in virtual organizations

The authors in [12] show the need to make several clouds collaborate around a virtual organization. The resource provided by one cloud is usually limited and some applications need the services of several clouds in order to provide a collective service. They proposed a secured collaboration platform entitled “Cloud VO” which takes into account safety policies of the Clouds partners. Our paper deals with the same collaboration spirit involving several clouds while allowing an organization partner to the virtual organization to freely find configurable computer science resources. The cloud infrastructure we are proposing allows each partner organization to create its own resources and users while keeping control of its own assets. In [13], the authors deal with the evolution of online labs toward Cloud Computing. The cloud computing SaaS (Software as Service) proposed in [13] provides participants with an environment that allows for network conferencing through the BigBlueButton platform. The platform allows each guest participant to connect and start a collaborative or individual session in the lab. The paper is also concerned with distance lab resources available in the cloud by identifying the web resources through a centralized model, physical resources through the decentralized model. In [14], the authors show the relevance of combining, through a private cloud, real and distance labs for an efficient sharing of lab platforms. The resources provided in [14] are of the SaaS type, which does not offer the opportunity to cloud users to shop freely.

Owing to multiple resources to manage and share, within the collaborative area, the paper proposes two models for sharing resources based on cloud which are the corner stones of the virtual organization: the decentralized and the centralized models.
4. Proposal for cloud based models for sharing resources

4.1. Centralized model

In the centralized model, a community Cloud infrastructure is set up in which universities will collect data (virtual machines, stocking space…) and pay on usage. Possibly, each university may offer its own software (applications, data), hardware (scientific tools) and human resources to other universities. The shared material resources must be available through a web interface. Partner universities do not collaborate directly but through the centralized infrastructure to access resources as shown in Figure 2.

![Centralized Architecture](image)

Figure 2. University Cloud virtual organization: Centralized architecture.

Having all universities share the same Cloud infrastructure facilitates resource sharing and mobility in the virtual organization, especially if the infrastructure is accessible via web.

This model is based on a strategy for pooling resources and proposes using computer science resources on demand. It allows member organizations to externalize, with some flexibility, all or part of their information systems (workplaces, servers, applications, stocking) and their equipment. It offers a community platform for exchanging good practices and making resources available, and training in digital tools and usage.

4.2. Decentralized model

For universities having non accessible equipment through the web, we propose the decentralized model as shown in picture 3, which allows each university to have its own Cloud infrastructure that will play the role of gateway. This is necessary because this kind of equipment requires direct connection to the computer with special cables.

![Decentralized Architecture](image)

Figure 3. University Cloud virtual organization: Decentralized architecture.
This gateway will connect all outsourced computer equipment. Thus, universities which want to access remote resources will pass through gateway. The latter will put to their disposal preconfigured virtual machines to manipulate equipment.

5. Implementation of a cloud computing solution IaaS (Infrastructure as a Service)

To implement our cloud infrastructure, we chose OpenStack platform for several reasons: (1) its architecture is modular and open, (2) the control access is based on roles providing the ability to create multiple types of administrators, (3) the ability to offer the network as a service, (4) the ability to manage quotas providing a flexibility in resource management.

5.1. Deployment architecture

Figure 4 illustrates the deployment architecture of IaaS solution composed of three nodes: Compute node, Control node, Network node.

![Deployment Architecture Diagram]

**Architectural description:**
- **Control node**: It is composed of services: Glance, Cinder, Keystone, Dashboard and part of Nova service.
- **Network node**: The network controller provides essential network services such as DHCP, switching, (Layer 2 switching), routing (Layer 3 routing), Floating IPs and connectivity metadata.
- **Compute node**: executes the compute service as well as the switching agent. This server also supports hypervisors (KVM in our case). It will host virtual machines.
- **External network**: allows our virtual machines to access internet. So our virtual machines will have access to the internet using the floating IPs.
- **Data network**: is used by the instances for inter-instances communications that do not belong to the same tenant. In our case, we use VLANs to isolate traffic from different tenants. The inter-instances communications belonging to the same tenant will be directly switched to the compute node.
- **Network management**: is used for internal communication between the OpenStack components.

5.2 Management console (Dashboard)

The Horizon graphical interface is a extensible web application that allows administrators to cloud and
users to control their computing, networks and storage resources.

As administrator of cloud, Horizon provides an overview of the size and state of your cloud. You can create users and projects (tenant), assign users to projects and set limits on resources for these projects. Horizon provides users a self-service portal to provision their own resources within the limits set by administrators.

The OpenStack menu is composed of two tabs (Project, Admin) for administrators and Project for users only.

Here are the steps for creating an instance and its association with storage space.

**Step 1: Creating a virtual machine (instance)**

a) We first start an instance as shown in Figure 6.

![Figure 5. Creating a virtual machine (1).](image)

b) Choice image type and the machine characteristics.

![Figure 6. Creating a virtual machine (2).](image)

c) Choice of key pair and security rules.
d) Choice of network in which the instance is pending

Overview instance actually created.

Overview of the access to the virtual machine console, which can also be controlled directly through the remote connection tools like, VNC, RDP, SSH, etc. the virtual machine can be a server or a client GUI.

**Step 2: Association of storage space to the virtual machine**

a) Creating storage space
b) Definition of name, type and size.

![Create Volume](image1)

Figure 11. Creating storage space (2).

c) Association of storage space to the instance

![Manage Volume Attachments](image2)

Figure 12. Association of storage space to the instance (1).

Overview of storage space associated with an instance
6. Conclusion and future work

Face to the difficulties encountered in the area of higher education and research, we proposed a pragmatic solution based on cloud computing in the context of a virtual organization. This rapidly expanding technology allows organizations to have online directly the infrastructures and software with usage billing. This will avoid investing heavily in infrastructure. We have shown that a virtual organization can be organized around a cloud infrastructure to enable universities to supply resources self-service. To facilitate the sharing of resources, two models have been proposed: the centralized model for the sharing of resources accessible via web and the decentralized model for the sharing of physical resources not accessible via web.

In perspective, we will integrate in the cloud a product of identity federation based on the web to decentralize users’ authentication in their home organization.

References


