SUDAN UNIVERSITY OF SCIENCE & TECHNOLOGY
FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

SUST CLOUD COMPUTING

AUGEST 2014

THESIS SUMITTED AS A PARTIAL REQUIREMENTS 0F B.Sc. (HONOR) DEGREE
IN COMPUTER SCIENCE

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

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AUGUST 2014

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آيـــــــــــــة

قال تعالى :

﴿وعَلَّمَ آدَمَ الْأَسْمَاءَ كُلَّهَا ثُمَّ عَرَضَهُمْ عَلَى الْمَلَائِكَةِ فَقَالَ أَنْبِئُونِي بِأَسْمَاءِ هَٰؤُلَاءِ إِنْ كُنْتُمْ صَادِقِينَ (31)قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَاۖ إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ (32)﴾

سورة البقرة

الحــمـدلله

الحمد لله رب العالمين.. صاحب العظمة والكبرياء الحمْد لِلَّه الَّذِي منَّ عَلَيْنَا بِالإسلام،الحمْدُ لِله رَبِّ العَالمِيْنَ، الحَمْدُ لله الَّذِي لَهُ ما فِي السَّمَواتِ وما في الأرْضِ ولَهُ الحمْدُ في الاول والآخِرِ وهُوَ الحَكِيْمُ الخبِيْرُ، الحمْدُ لله فَاطِر السَّمَواتِ والأرْضِ، الحمْدُ لله الَّذِي أنْزَلَ على عَبْدِهِ الكِتَابَ ولم يجْعَلْ لَهُ عِوَجًا الحمْدُ لله الَّذِي لم يَتَّخِذْ صَاحِبَةً ولا ولدًا ،وأشهدأن ل االه إلاالله،وحده لاشريك له،له الملك وله الحمد، وهوعلى كل شئ قدير، وأشهد أن محمدًاعبده ورسوله.

لكَ الحمدُ حمداً نستلذُّ به ذكراً *** وإن كنتُ لا أحصي ثناءً ولا شكرا
لكَ الحمدُ حمداً طيباً يملا السما *** وأقطارها والأرضَ والبرَّ والبحرا
لكَ الحمدُ حمداً سرمدياً مباركاَ *** يقلُّ مدادُ البحرِ عنْ كنهِهِ حصرا
لكَ الحمدُ تعظيماً لوجهكَ قائماً *** يخصكَ في السراءِ مني وفي الضرا
لكَ الحمدُ مقروناً بشكركَ دائماً *** لكَ الحمدُ في الأولىولك الحمدُ في الأخرى
لكَ الحمدُ موصلاً بغيرِ نهايةٍ***وأنت إلهي ما أحقَّ وما أحرى

شكر واعتراف

الشكر لله سبحانه وتعالى من قبل ومن بعد ....

لو كنت أعلم فوق الشكر منزلة أوفى من الشكر عند الله في الثمن

الشكر لأسرة كلية علوم الحاسوب وتقانة المعلومات أساتذة وعمال وطلاب فقد كانت لنا نعم الزاد وخير المعين .

أيضا الشكر لمدينة افريقيا للتكنولوجيا على توفيرها لأجهزتها من أجل إتمام هذا المشروع.

الشكر كل الشكر نجزيه إلى أ/ابتهال نور الدين شمس العلا على كل ماقدمته لنا فقد كانت الناصح والمرشد والدليل فلها منا أسمى آيات الشكر والتقدير.

أيضا الشكر إلى :

أ- محمد عبد الله .

أ- محمد صديق .

وكل من قدم لنا يد العون والمساعده ..

إهداء

الـــى الينابيـــــع الصافيـــــة على طول الطريق

زملائي

والـــــى الشمـــــــوع التي انـارت لنا الدرب

أساتذتي

الـــى تلك النوارس التي ما كلت وهي ترفرف فوقي بأجنحتها لتقيني حر الهجير

أخوتي

الـــى من سقاني الصبر حبا وأهداني من الحب نبعا ... الى قدوتي أبد الدهر

أبي

الى من ضمتنـــــــي في حناياها عمرا .. الى مهد أحلامي وغاية آمالي .. بوابتي الى الجنة

أمي

ABSTRACT

The educational and academic environments one of the changeable environment especially in the areas of computer and information technology, because the techniques used in education and the college laboratories are changed continuously due to the rapid evolution in technology.

The college of Computer Science and Information Technology in Sudan University of Science and Technology one of the leading colleges in the fields of computer and information technology .This college faces many problems , including the failure to achieve privacy for the students data within the labs because the computers are shared by number of students, and the administrators always use programs to clear the data from computers once the device shutdown to save storage capacity and protect the hardware from viruses and malicious software's. In addition there is high cost for providing programs with license for each device and it is a headache to maintenance these programs. Moreover, the transfer of data from the devices inside and outside the university and vice versa is not safe.

The research aims to provide system offers storage as a service. And provide virtual environment containing tools used to write programs in the laboratory -platform as service- for the users within the college via the Internet.

Cloud computing technique used to implement solution for these problems, which is a new technology with many features such as confidentiality, scalability, flexibility, reliability, and reduce operations and cost.

The solution in this research has been design using cloudstack to offer platform as service, which provides environment for users to complete their jobs and ownCloud which provides storage as service, where people can store their files. Furthermore the first service tested by implementation of a program written in Java within the operating system environment (windows), the second service has been tested by uploading and downloading files from and to the cloud.

A private cloud environment has been offered for users in the college of Computer Science and Information Technology, these cloud managed by the same college and grantee the level of reliability and confidentiality required, the users can access the cloud from anywhere at any time via the Internet, and reduced the cost of buying software and maintenance them.

المستخلص

تعتبر البيئات التعليمية والجامعية من البيئات المتغيره بصوره كبيره خصوصاً في مجالات الحاسوب وتكنلوجيا المعلومات، لأن التقنيات المستخدمة في المناهج التعليمية والمعامل التطبيقيه تتغير بصورة مستمرة ويرجع ذلك للتطورالمتسارع في التكنولوجيا.

كلية علوم الحاسوب وتقانة المعلومات بجامعة السودان للعلوم والتكنولوجيا من الكليات الرائدة في مجالات الحاسوب وتكنلوجيا المعلومات ؛ تواجه هذه الكليه عدد من المشكلات لمواكبة التطور المستمر في مناهجها منها عدم تحقيق الخصوصية لبرامج وبيانات الطلاب داخل أجهزة المعامل، نتيجة لاستخدام جهاز الحاسوب الواحد من قبل عدد من الطلاب. ويتم ايضاً مسح جميع هذه البيانات والبرامج بمجرد إغلاق الجهاز لتوفير سعة التخزين داخله ولحمايت الأجهزة من انتشار الفيروسات. إضافةً لذلك توجد تكلفة في توفير البرامج لكل جهاز علي حدة وصعوبة عملية صيانة هذه البرامج. علاوة على ذلك، المشاكل التي تحدث بسب نقل البيانات من داخل أجهزة الجامعة لخارجها والعكس مثل إنتقال الفيروسات والبرامج الخبيثه وغيرها

يهدف البحث لتوفير نظام يقوم بتقديم خدمات التخزين(storage as service). وتوفيربيئة تخيلية تحتوي على تقنيات تُستخدم لكتابة البرامج داخل المعامل(platform as service) للمستخدمين داخل الكلية عن طريق الإنترنت.

أُستخدمت تقنية الحوسبة السحابية (cloud computing) كحل لهذه المشاكل، وهي إحدى التقنيات الجديده التي توفر عدد من المميزات مثل السرية، إمكانية التوسع، المرونة ، الإعتمادية و تقليل العمليات و التكلفة.

تم في هذا المشروع تصميم النظام بإستخدام برنامج (cloudstack) الذي يوفرخدمة (platform as service) التي تقدم بيئة كاملة يمكن للمستخدم إستخدامها لتنفيذ عمله. و برنامج (ownCloud)الذي يقدم خدمة (storage as service) حيث يمكن للمستحدمين تخزين ملفاتهم .كما أُختبرت الخدمة الأُولى بتنفيذ برنامج مكتوب بلغة الجافا داخل بيئة نظام التشغيل (windows). أما الخدمة الثانية فقد تم إختبارها برفع ملف من جهاز المستخدم الي السحابة وتنزيل الملف من السحابة لجهاز المستخدم وعرضه.

وفرت السحابة بيئة خاصة بمستخدمي كلية علوم الحاسوب وتقانة المعلومات حيث تدار من قبل الكلية نفسها وذلك حتى تتوفر فيها الموثوقية والسرية المطلوبة. يسطيع المستخدمون الوصول لبياناتهم من اي مكان وفي اي وقت وذلك لأن السحابة يتم الوصول إليها عبر الأنترنت، كما قللت تكلفة شراء البرامج وصيانتها.

LIST OF TERMS

Term	Description
SUST	Sudan University of Science and Technology
NIST	National Institute of Standards and Technology
CSIT	Computer Science and Information Technology
IaaS	Infrastructure as a Service
Paas	Platform as a Service
SaaS	Software as a Service
IBM	International Business Machines
VCL	Virtual Computing Lab
NCSU	North Carolina State University
RHEL	Red Hat Enterprise Linux
UML	Unified Modelling Language
EA	Enterprise Architect
AWS	Amazon Web Services
API	Application programming interface
Amazon EC2	Amazon Elastic Compute Cloud
VM	virtual machine
OS	Operating System
YUM	Yellow dog Updater Modified
SELinux	Security-Enhanced Linux
NFS	Network File System
NTP	Network Time Protocol
KVM	Kernel-based Virtual Machine
UI	User Interface
LADP	Light Weight Directory Access Protocol
MS-DOS	MicroSoft-Disk Operating System
BSD	Berkeley Software Distribution
CentOS	Community Enterprise Operating System
xCAT	Extreme Cloud Administration Toolkit
PC	Personal Computer
UEC	Ubuntu Enterprise Cloud
url	Unified Resource locator

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CHAPTER 1

INTRODUCTION
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1.1 INTRODUCTION

Cloud computing has become an attractive area of research, nowadays an increasing number of organization around the world either adopting cloud based solutions or are seriously considering a move to cloud computing because it offering many benefits including security, scalability, flexibility, reliability, decreased operational and support costs. [1].

The National institute of standards and technology (NIST) define cloud computing as following:

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." [2].

1.2 PROBLEM OF THE RESEARCH

In an academic and scientific environment such as universities there are large network, which it is distributed over many branches and used by huge numbers of students, teachers, employees, researchers and technical, whom use this network and computers to do their jobs and store their data and information .

The number of users in these environment are increased periodically, and there is a high cost of material and time to provide hardware and software for everyone , furthermore the software maintenance require effort to each device independently. These processes in information technology colleges waste more effort and time, because technologies and software used are changed continuously.

The college of Computer Science and information Technology (CSIT) in -Sudan University of science and technology- (SUST) is taken as a case study for an academic environment ,find out the students and researchers need to store their files and data .The computers in the college Laboratories shared by multiple users across the time, the users cannot gain the confidentiality and privacy to their data, and this means that there is considerable need for greater storage capacity and the separation of data for each user from the others.

All users in the university need to transfer data from computers in university to the outside and vice versa which requires an external storage device and sometimes it is not reliable; it may not work, may carry malicious software and data

So there is considerable need for the existence of this data in place where the user can access it from anywhere and at any time.

Furthermore software installation and maintenance process for PCs in labs depends on the PC performance and it will be a headache to done for each PC, beside that provide software with license for each PC has large cost rests on the university.

There are some service provider via the Internet provides solutions for what we have mentioned in the previous points (storage space, platform), but they are not reliable in terms of that the user cannot be sure if they are having a real confidential or not, because users don't know who manage this service or their aims and what the level of protection they offered to their users, so there is a considerable need for a place run by SUST and guarantee the level of protection and service needed.

1.3 OBJECTIVES

A. Build private cloud with number of services to SUST users:

1- Infrastructure to offer storage spaces for users and separate between users to provide security and privacy and access their personal files from any computer with internet access.

2- Software that could be used by number of users at same time.

3- Platform to allow users to develop their application without install additional resource.

B. Provide the first step to move to virtual labs.

C. Reduce using external storage devices.

1.4 SCOPE OF RESEARCH

There are three main deployment models of cloud computing: public, private and hybrid –as will be mention in the next chapter - we choose to work on private cloud model, because it have low cost on long term and more customizable. The solution based on open source software to be a good reference for students in SUST for later devolving.

We are going to cover the three service models of cloud computing , taking one example for each model as follow: in the infrastructure as a service model (IaaS) we choose to provide storage service as result of needing to share and store

files between teachers and students .In the platform as a service model(PaaS) of cloud computing we decide to provide the tools needed for java , because it's the most used tool in CSIT labs .We decide to provide cloud based antivirus in the software as a service model (SaaS) , because SUST have a problem to provide antivirus license for each PC in labs.

1.5 METHODOLOGY

Reading and reviewing of previous studies were used in this research, CentOS operating system used to provide the environment. Both cloudStack and owncloud tools used to apply the basic concept of the research furthermore a web pages web pages developed that work with cloud API to offer the desired services for users.

1.6 ORGANIZATION OF RESEARCH

Beside this chapter, this research consists of five chapters, as following:

Chapter 2 consists of two sections, first section discusses a background of cloud computing and the second one discusses previous studies that related to the project.

Chapter 3 which contains tools and platforms witch used in the research.

Chapter 4 which discusses analysis for the system.

Chapter 5 which contains the implementation for the system.

Chapter 6 contains the results of this research and recommendation.

CHAPTER 2

BACKGROUND OF CLOUD AND RELATED STUDIES

SECTION ONE

BACKGROUND OF CLOUD COMPUTING

2.1 INTRODUCTION:

Cloud computing is a new concept depending on existing technologies such as grid computing, virtualization and web technologies; it refers to the delivery of computing resources over the Internet.

This section discuss theoretical background of cloud computing.

2.1.1 Distributed Computing:

A distributed computer system consists of multiple software components that are on multiple computers, but run as a single system. The computers that are in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network.

The distributed system can consist of number s of different type of machine. The goal of distributed is make the system Scalable and that by adding more machine to system and it also provide the redundancy characteristic and that by using Several machines to provide same service in same time [3].

2.1.2 Utility Computing:

Utility computing is a model that provides computing resources and infrastructure management to the customer as needed. Moreover, it allows users to operate and manage their own computing resource by themselves.

Utility computing considered the basis of Cloud computing, grid computing and managed IT services [4].

2.1.3 Grid Computing:

Grid computing is a computer network in which each computer's resources are shared with every other computer in the system. Processing power, memory and data storage are all community resources that authorized users can tap into and leverage for specific tasks. Grid computing can be simple when all machines run same operating systems or complex when the machines and operating systems being different in types or vendors [5].

2.1.4 Cluster Computing

A computer cluster consists of a set of loosely connected or tightly connected computers that work together as a single system. The components of a cluster are usually connected to each other through fast local area networks (LAN). Etch server run its own operating system and all operating systems from same type [6].

2.1.5 Cloud Computing

Cloud computing refers to application and services that run on a distributed network using virtualized resource and accessed by common internet protocols and network standards, including the process of managing the virtualized resources in abstracted from the user [7].

2.1.5.1 Cloud computing characteristics

Cloud computing has many Characteristics such as:

- On-demand self-service means that customers (usually organizations) can request and manage their own computing resources.
- Broad network access allows services to be offered over the Internet or private networks.
- Pooled resources means that customers draw from a pool of computing resources, usually in remote data centers.
- Services can be scaled larger or smaller.
- A service is measured and customers are billed accordingly [2].

2.1.5.2 Cloud computing service models

Depending on services offered by cloud computing, there are three major Service models:

- **Software as a service (SaaS)**

SaaS is a kind of applications that is available as a service to users; it delivers over the Internet, eliminating the need to install and run the application on local computers, in order to simplify the maintenance and support.

One of the main differences of using such an application that the application is usually used without being able to make a lot of adaptations and preferably without

tight integration with other systems.(Pre-made application along with any required software, operating system, hardware, and network are provided) [1].

- **Platform as a service (PaaS)**

PaaS supplies all tools that is needed to build applications directly from the internet with no local software installation (An operating system, hardware and network are provided) [1].

- **Infrastructure as a service (IaaS)**

IaaS is the delivery of computer infrastructure that is a fundamental resource such as processing power, storage capacity and network to customers (model provides just the hardware and network).

The benefits of IaaS include rapid provisioning, ability to scale and pay only for what you use [1].

2.1.5.3 Deployment model of cloud services

Cloud computing is offered in different deployment models:

- **Public clouds**

The cloud infrastructure is provisioned for anyone who wants to sign up and use them. Public clouds are run by vendors, and applications from different customers are likely to be mixed together on the cloud's servers, storage systems, and networks [8].

While the public cloud is big business and attracts the world's largest providers, such as Amazon Web Services and IBM, access to the public cloud itself is often inexpensive or free to establish and users are often, but not always, smaller scale enterprises or individuals. The public cloud is sometimes regarded as less secure than private clouds [8].

The main benefits of using a public cloud service are:

  - Easy and inexpensive set-up because hardware, application and bandwidth costs are covered by the provider.
  - Scalability to meet needs.
  - No wasted resources because you pay for what you use [9].

- **Private clouds**

They are built for the exclusive use of one organization, providing the utmost control over data, security, and quality of service [8].

The main benefits of using a private cloud service are:

- Security: Cloud computing is extremely secure, and with the private cloud your data sits behind your company's dedicated firewall. Further with the cloud, you don't have to worry about a stolen laptop or desktop.
- Redundancy: With private cloud you have even greater control over redundancy because you get to design your own environments with all of the redundancy you require [11].

- **Hybrid clouds**

Hybrid clouds combine both public and private cloud models. This model introduces the complexity of determining how to distribute applications across both a public and private cloud. If the data is small, or the application is stateless, a hybrid cloud can be much more successful than if large amounts of data must be transferred into a public cloud for a small amount of processing [8].

2.1.6 Virtualization

Virtualization means to create a virtual version of a device or resource, such as a server, storage device, network or even an operating system, this resource is independent of the physical hardware layer.

Virtualization can reduce complexity for end users while allowing an organization's IT resources to be utilized more effectively. But cloud computing delivering access to those components on-demand as a service, further reducing complexity, cost and burden. Essentially, virtualization is a logical action for businesses to take when considering the adoption of a cloud computing strategy [12] [13].

SECTION TWO
RELATED STUDIES

2.2 INTRODUCTION

This section demonstrates three previous researches, and compares them with this research topic. These related works take a university environment as case study or cloud computing as main idea.

2.2.1 Case Study of North Carolina State University's Virtual Computing Lab

Done by Jithesh Moothoor and Vasvi Bhatt in 15 Dec 2009 and this study about The Virtual Computing Lab (VCL) which is cloud computing idea developed at the North Carolina State University (NCSU) through a collaboration of its College of Engineering and IBM Virtual Computing Initiative to address a growing set of computational needs and user requirements for the university.

This system can deliver user required solutions for variety of service environments anytime and anyplace on demand/reservation, and this study specifically focus on a cloud computing implementation methods through the VCL, how it helps within a research-oriented educational institution of higher learning. This study offered the following services:

Firstly IaaS in this service compute service (Physical Machines, Virtual Machines and OS-level virtualization), network service and storage service are provided.

Secondly PaaS in this service solution stacks (java,php,.net) and storage (databases and file storage) are offered.

Finally SaaS in this service virtualization solutions and terminal services solutions (VMware, XEN, MS Virtual Server, Virtuoso, and Citrix) are done [8].

2.2.2 Case Study Cloud Computing for Universities in Menoufia University

These study done by Mohamed Moheb El-Shorbagy, Mohamed Mohamed Zein El-Dein and seven others ,as graduation project from faculty of electronic engineering in 2012, the mainly idea of the project is implementation of the university data-center experimental education in IT field, including servers and

network components, develop the University data-center using the cloud computing and virtualization . The study offered a number of services as follow:

- Offered the virtual servers with variant specifications to facilitate of virtualization-the practical implementation of the large Graduation Projects.
- Virtual/Thin applications to facilitate the academic study in labs.
- They offered Virtual Desktops for researchers, professors and university employees [14].

2.2.3 Case Study Cloud Computing Management

This study done by in Sudan University of Science and Technology, as graduation project from faculty of computer science and network in Aug 2010 which aims to apply the concept of cloud computing by deliver storage as a service for the users.

They use Ubuntu enterprise cloud UEC which is Ubuntu distribution that support cloud computing and Eucalyptus tool to implement the basic idea of the project [15].

2.2.4 The Research vs. Previous Studies:

This research compared with the related works in next table.

[Table0-1]The Research vs. Previous Studies

<table>
<tr><td>Study Number</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="3">Similarities</td><td colspan="3">The aims of all projects is same in achieve quality of service and utilization to enhanced university environment using cloud computing.</td></tr>
<tr><td colspan="2">Implemented the three service model of cloud computing</td><td></td></tr>
<tr><td colspan="3">Used MySQL for Data Base and apache (open source web server).</td></tr>
<tr><td rowspan="2">Differences</td><td colspan="2">Both studies and our study have different example for each service model.</td><td>It implements one service model (IaaS).</td></tr>
<tr><td>The tools they are used:IBMxCAT, VM loader, VMware ESXi and VMware ESX.</td><td>The tools they are used: VMware ,vCloud, (vSphere 5 & vCloud Director) cloud solution and OpenStack cloud solution.</td><td>The tools they are used: Eucalyptus and Ubuntu OS</td></tr>
</table>

CHAPTER 3

TOOLS AND PLATFORM

PAGES (11 – 14)

3.1 INTRODUCTION:

This chapter describes the tools and platforms that will be used in the research.

3.2 TOOLS AND PLATFORM

3.2.1 CentOS 6.3

The CentOS Linux distribution is a stable, predictable, manageable and reproducible platform derived from the sources of Red Hat Enterprise Linux (RHEL) [16].

3.2.2 Enterprise Architect (EA)

EA is a fully featured, UML based modeling tool from Sparx Systems. EA features a graphical environment in which to construct your diagrams, and produces crisp, easy to view images. It also has many advanced features that will enhance using of UML, such as the ability to generate definable documentation in HTML formats, and to export code in a variety of languages, with additional languages available via the use of technology templates [17].

3.2.3 VMware Workstation 10.0.0

It is tool that enables users to set up one or more virtual machines (VMs) on a single physical machine, and use them simultaneously along with the actual machine. Each virtual machine can execute its own operating system, including versions of Microsoft Windows, Linux, BSD, and MS-DOS [18].

3.2.4 Compression between above software's:

Next Table shows the comparison between open source software that can used to create cloud.

[Table0-1] Compare between Cloud Open software's

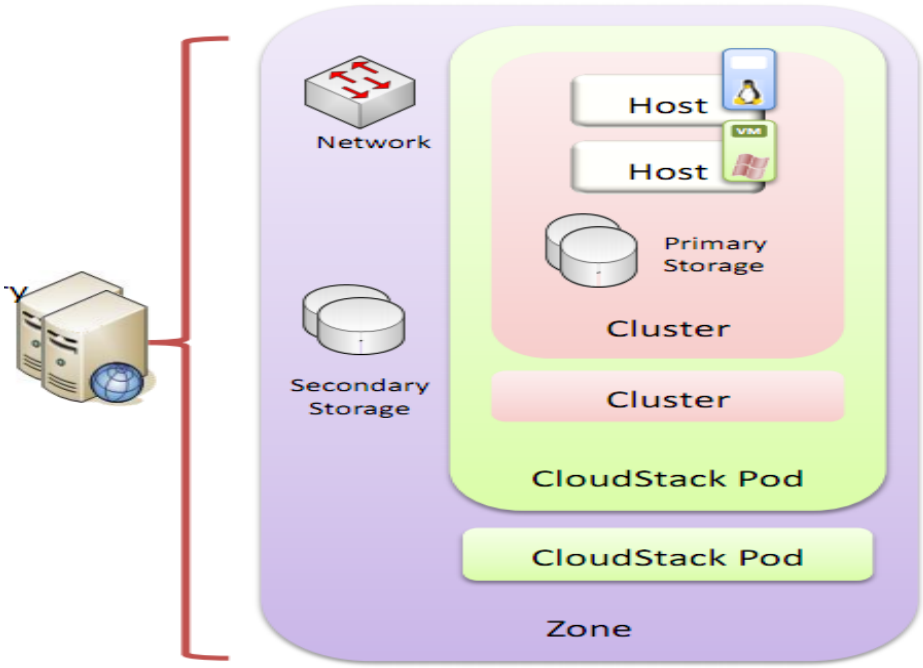
Open Source Software	**Advantages**	**Disadvantages**
OpenStack	-Large community. -Wide integration with storage, network and compute technologies.	-Lacks enterprise features. -Difficult to deploy and configure. -Lacks interoperability.
CloudStak	-Supported by Citrix and friends. -Battle tested and scalable. -Good documentation and clear implementation steps.	-Smaller community. -Fewer server, network and storage devices supported. -Less flexibility.
Eucalyptus	- Full API compatibility with Amazon EC2.	- Fragmented nature of its platform.
OpenNebula	- Include powerful VM placement algorithms. - Flexibility of control over the environment.	-Not currently support integration into an existing authentication system such as Kerberos or LDAP.

3.2.4.1 Determining the best choice:

In these research **cloudStack** open source software is selected to building the private cloud because:

- It allow user to coordinate virtualized servers, networking and network storage to provide infrastructure-as-a-service
- The architecture is simple compared with openStack and Eucalyptus.
- Compatible with Amazon EC2.
- Support for two major language (Python and java).
- Simple user interface.
- Good documented API

This Software delivers PaaS over the IaaS. There are number of components in cloudstack, will be configured, and it is illustrated as following:



[Figure 3-1] Cloudstack components

- Host (computing node) is a server contains the services which will be provisioned.
- Cluster is a group of hosts and their associated storage.
- Pod is collection of clusters in the same failure boundary.

- Primary Storage stores disk volumes for VMs in a cluster, configured at Cluster-level, close to hosts for better performance. Additionally, cluster has one primary storage at least.
- Secondary Storage stores all templates, ISOs and snapshots. Furthermore, configured at zone-level, and the zone can have one or more secondary storages. Beside that High capacity, low cost commodity storage available on it.
- Zone is Collection of pods, network offerings and secondary storage.
  Management Server manages and provides tasks.

3.2.5 OwnCloud Software

OwnCloud is free and open source software used to store files with different types. The number of connected clients and storage space in owncloud are not limited [23].

CHAPTER 4

SYSTEM ANALYSIS

PAGES (15 – 24)

4.1 INTRODUCTION

This section describes the system behavioral, using UML graphs. Enterprise Architect has been used to create the following UML diagrams for theoretical analysis of project.

4.2 ARCHITECTURE

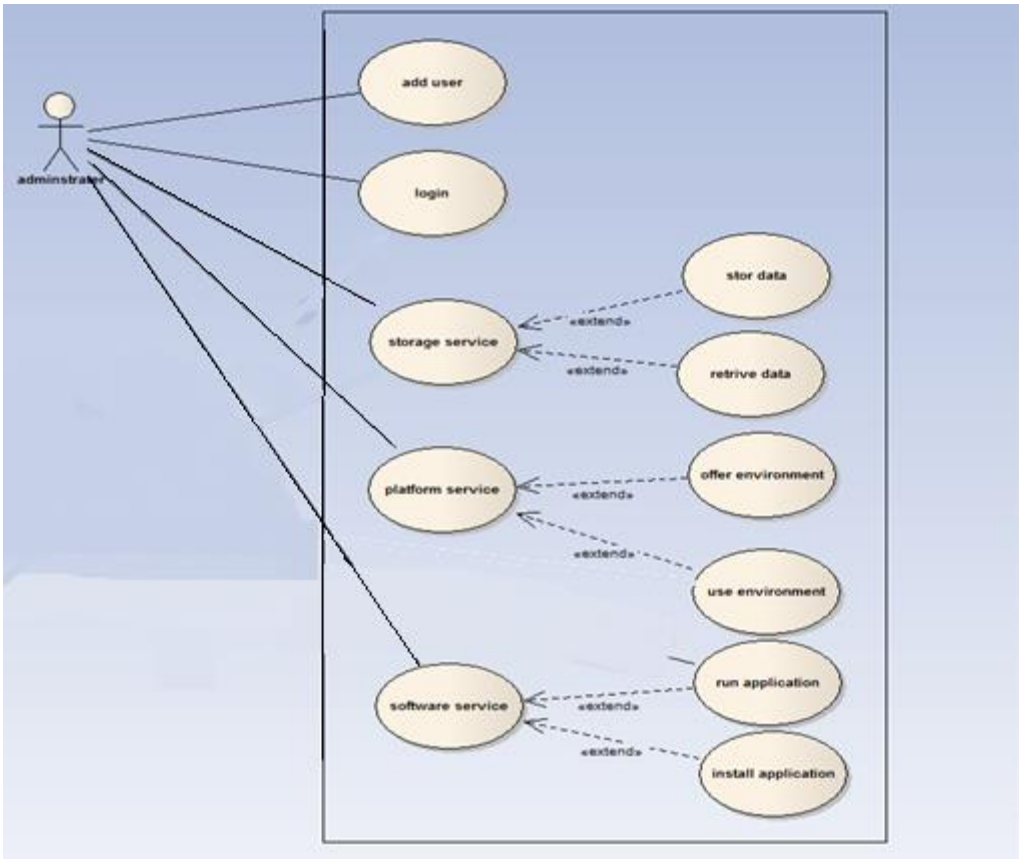
The system provides three services to SUST users: storage service (IaaS), platform service with java tools (PaaS) and antivirus (SaaS) as examples for provisioning are services for testing purpose.

There are two types of user administrators and end users. The end user includes a student, researcher, teacher and employee. The system offers the service to end users whom consume these services. The administrator is responsible of managing the service in the system.

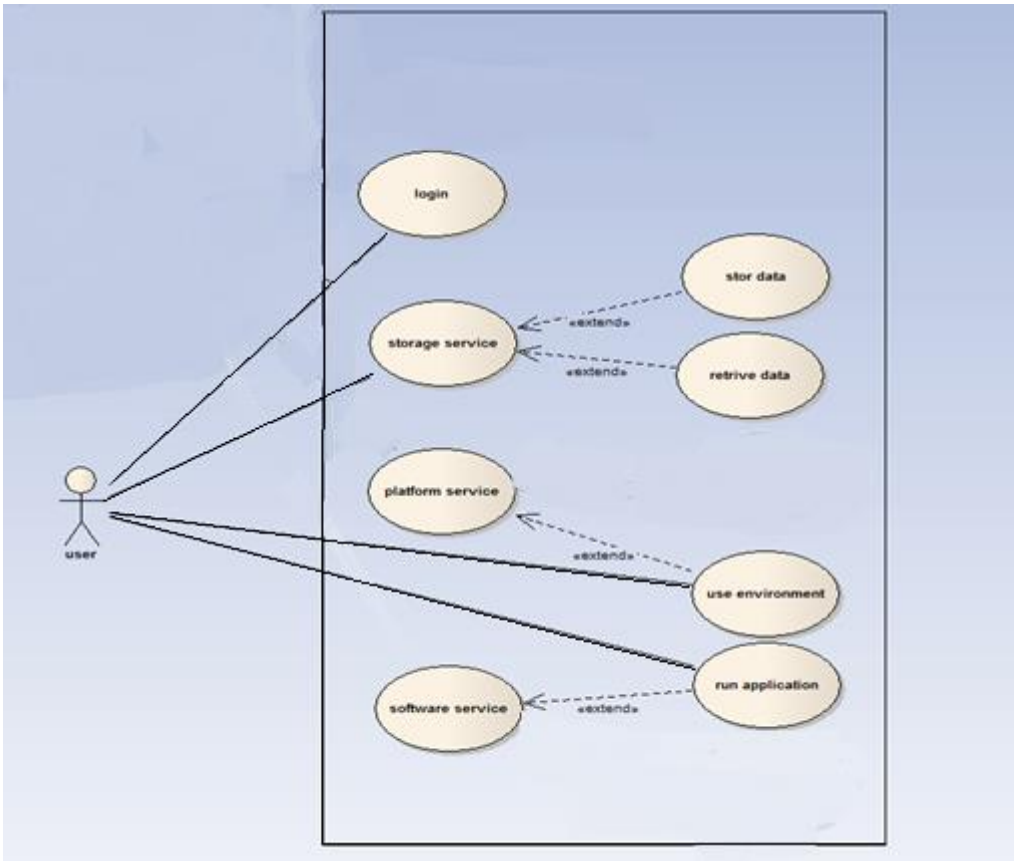
In cloud computing there are two main components in the system. The resources which will be provide to the user, more over the management process of these resources.

4.2.1 The Use Case Diagram

The following figure describes the main operation in the system.



[Figure 0-2] Administrator use case diagram



[Figure 0-2]User use case diagram

[Table 0-1] Use case diagram descriptions

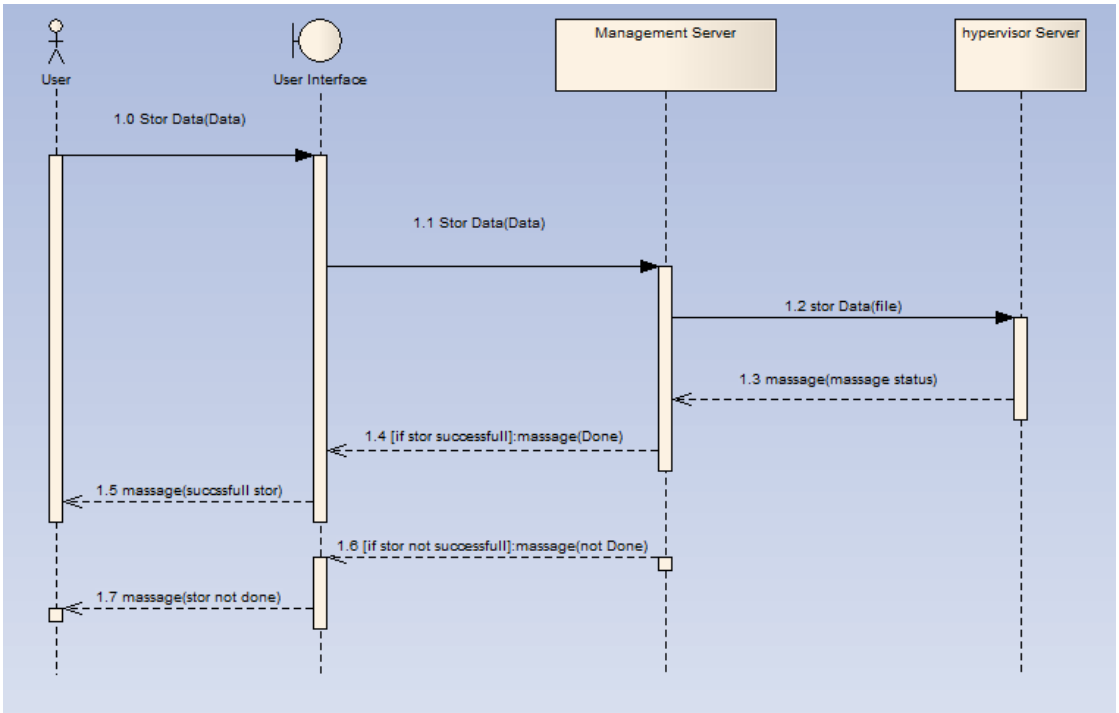
Use case Name	**Use case Description**
Login	Login to the System.
Add User	Administrator add user to the system.
Storage service	Using the cloud Storage Service.
Store data	Store data into the user space.
Retrieve data	Retrieve data from the user space.
Platform Service	Using cloud platform service.
Offer environment	Administrator offer environment for users to develop their application.
Use environment	Users used the offered environment to test and run their application.
Software service	Using the cloud software service.
Install application	The administrator installs software into cloud.
Run application	Use the software offered by the cloud.

4.2.2 IaaS Sequence Diagrams

There are three IaaS sequence diagrams illustrate three operations [reserve storage space, store data, and retrieve data] happen in SUST cloud and that as fallowing:

4.2.2.1 Store data (upload data)

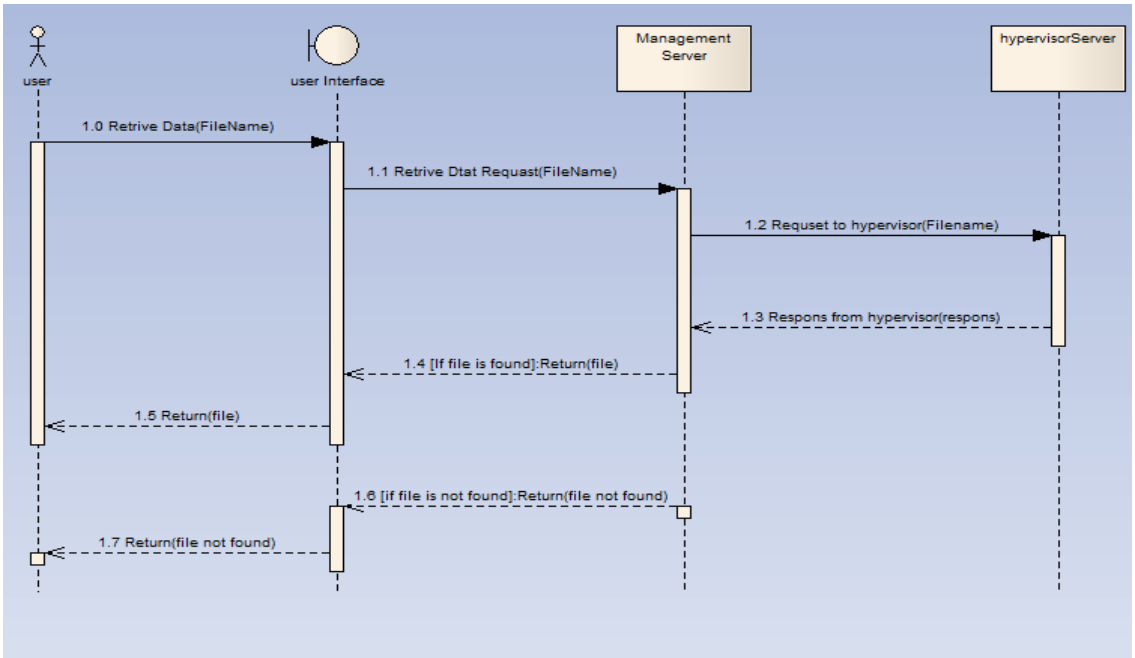
The user make request with the data to the management server to store his data, and management server response by store the data.



[Figure 0-3] Store data sequence diagram

4.2.2.2 Retrieve data (download data)

The user make request to management server to retrieve stored data and the management server response by return stored data to user.



[Figure 0-4] Retrieve data sequence diagram

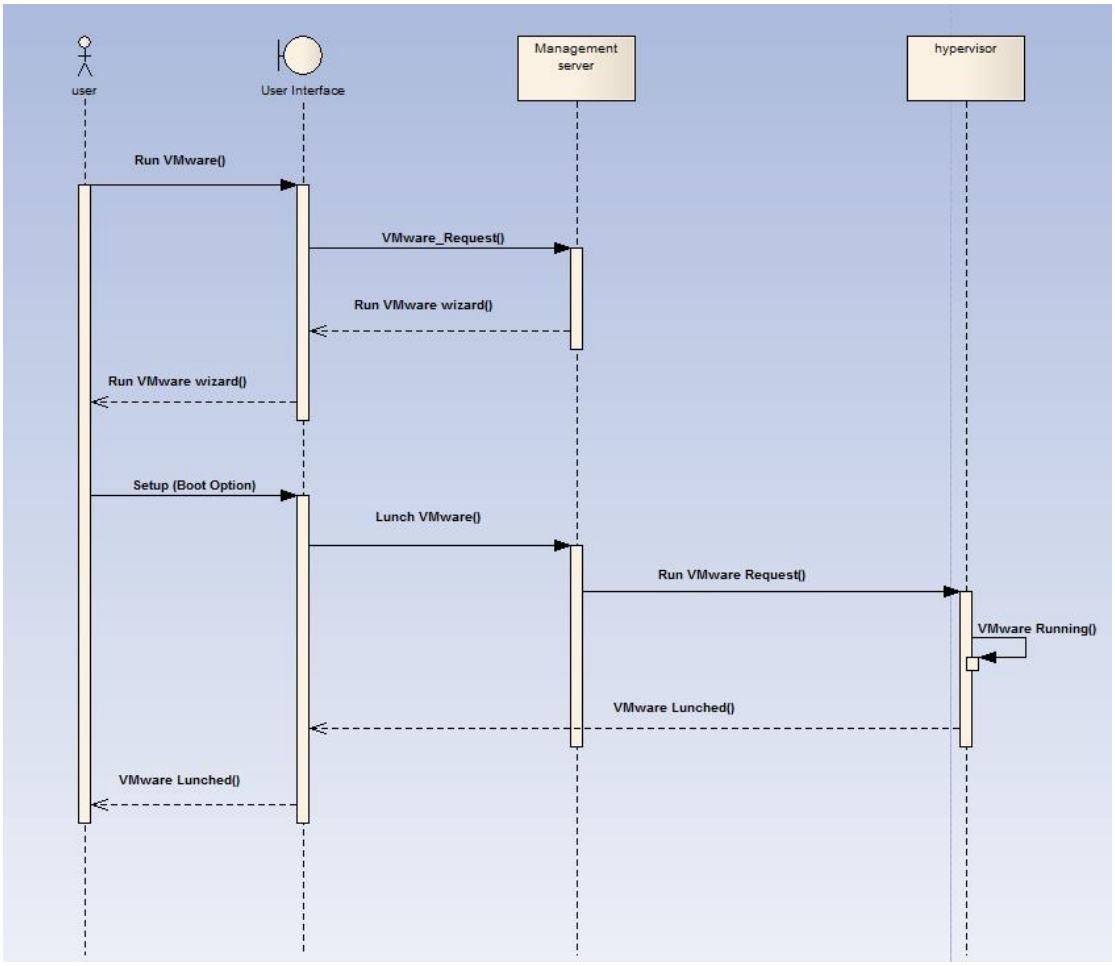
4.2.3 PaaS Sequence Diagrams

Diagrams illustrate two PaaS sequence: how the administrator can offer platform with the needed tools and application and how the user can access this platform as follow:

4.2.3.1 Administrator offer PaaS

The administrator can simply add platform either by adding operating system (OS) instance or preconfigured template with OS and associated application as follow:

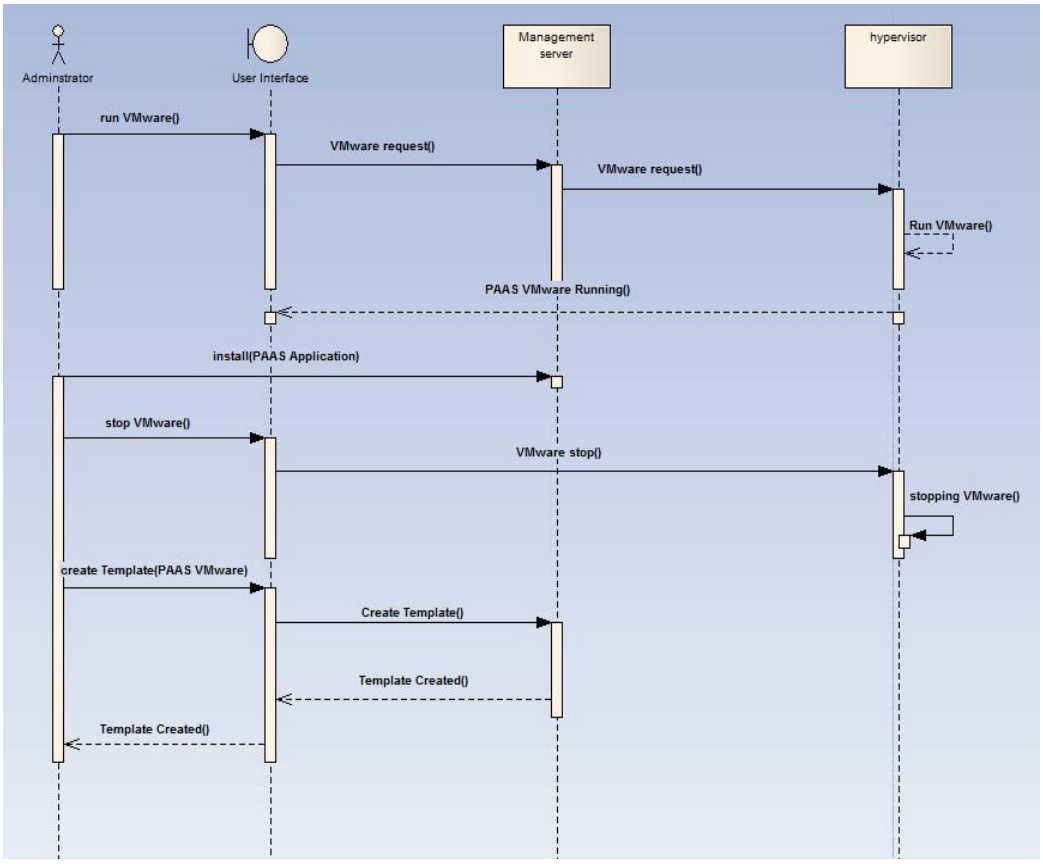
Create VM and install the suitable OS(ex:Windows), install all the application the administrator want to offer in the platform for users, stop the VM then create new template from it ,then any user can use it for booting and accessing all applications.



[Figure 0-5] Administrator PaaS sequence diagram

4.2.3.2 The user access the PaaS

All users in the system can create and run virtual machines (VM) in the term of service offering, disk offering and network offering that available for them.



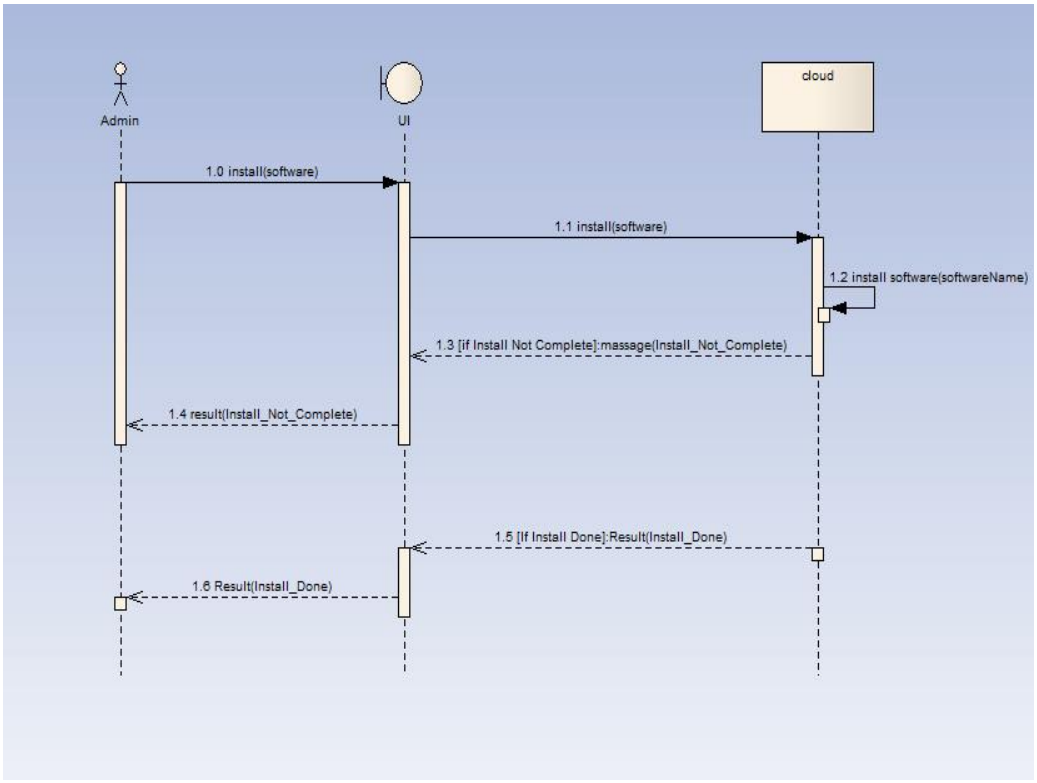
[Figure 0-6] User PaaS sequence diagram

4.2.4 SaaS Sequence Diagrams

Diagrams illustrate two SaaS sequence: how the administrator can install the software in cloud and how the end users can access the system to use the installed software and that as fallow:

4.2.4.1 Administrator install software

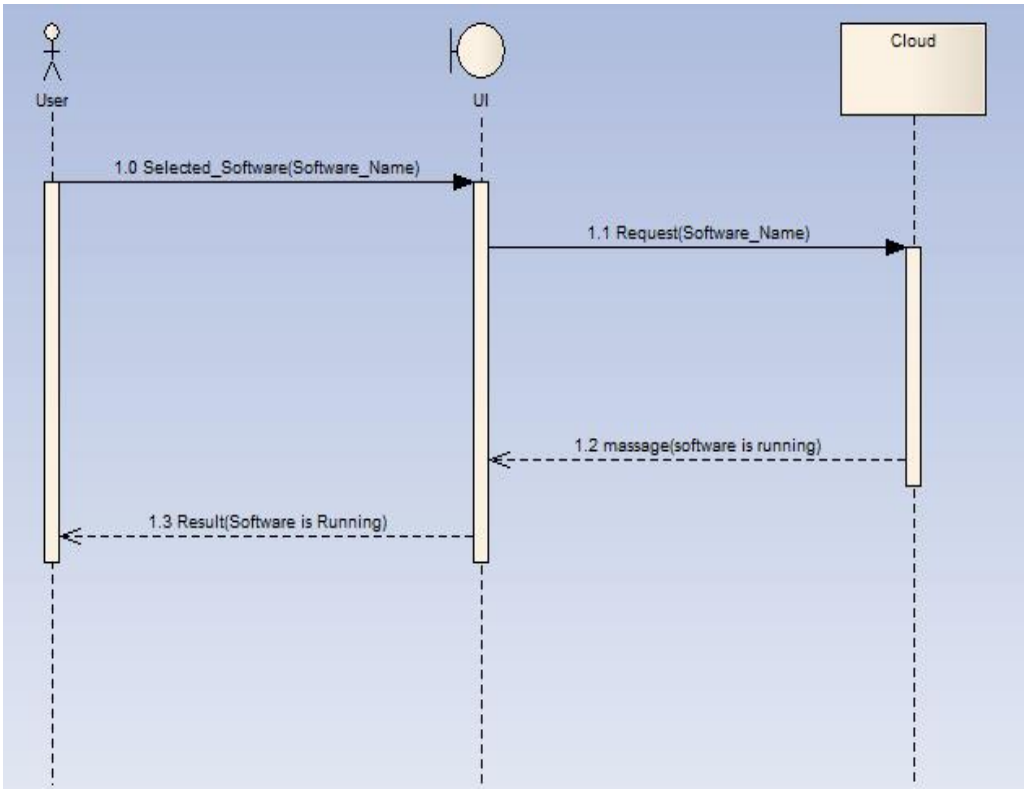
The administrator install all software's that the cloud will offer them and keep them ready to use.



[Figure 0-7] Administrator SaaS sequence diagram

4.2.4.2 End user use software in cloud

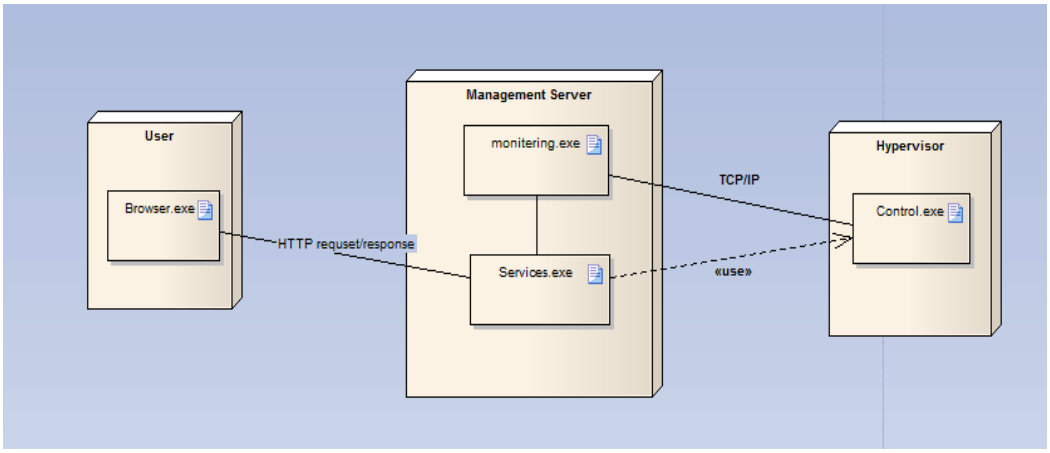
End user select software from a list of software's that offered by SUST cloud then the system run this software to user.



[Figure 0-8] End user SaaS Sequence Diagram

4.2.5 THE DEPLOYMENT DIAGRAM:

The following figure describes the physical deployment of the system.



[Figure 0-9] Physical deployment of the system

[Table 0-2] Deployment Diagram Descriptions

Artefact	**Description**
Monitoring.exe	Monitor all the resources users and services.
Services.exe	Contain all the service provided by the system.
Control.exe	Responsible of control the virtual environment.

CHAPTER 5

IMPLEMENTATION

PAGES (25 – 32)

5.1 INTRODUCTION:

This chapter shows the implementation steps and screen shots for the basic operation in the project.

5.2 IMPLEMENTATION STEPS:

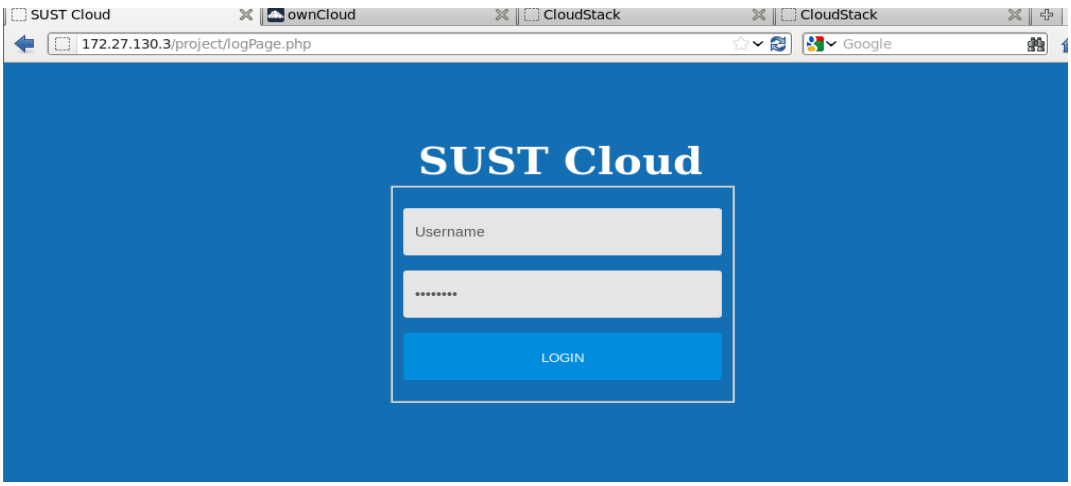
There are two cloud software used to obtain PaaS and IaaS(storage),those software(CloudStack and OwnCloud) and their components are configured in this project and that mentioned in details at APPENDIX [I-36][II-58].

After the configuration process complete successfully, we develop web pages that communicate with CloudStack API to provide the desired services, the communication with API was done through the HTTP protocol on secure port 8080 any request associate with API key ,signature and session key which create at the login operation for example to request the API to deploy new virtual machine we have to use deployVirtualMachine command and associate another information such as service offering and the template id which contain the preconfigured operating system:

```
http://localhost:8080/client/api?command=deployVirtualMachine&serviceOfferingId=1&diskOfferingId=1&templateId=2&zoneId=4&apiKey=miVr6X7u6bN_sdahOBpjNejPgEsT35eXqjB8CG20YI3yaxXcgpyuaIRmFI_EJTVwZ0nUkkJbPmY3y2bciKwFQ&signature=Lxx1DM40AjcXU%2FcaiK8RAP0O1hU%3D
```

5.3 RESULTS

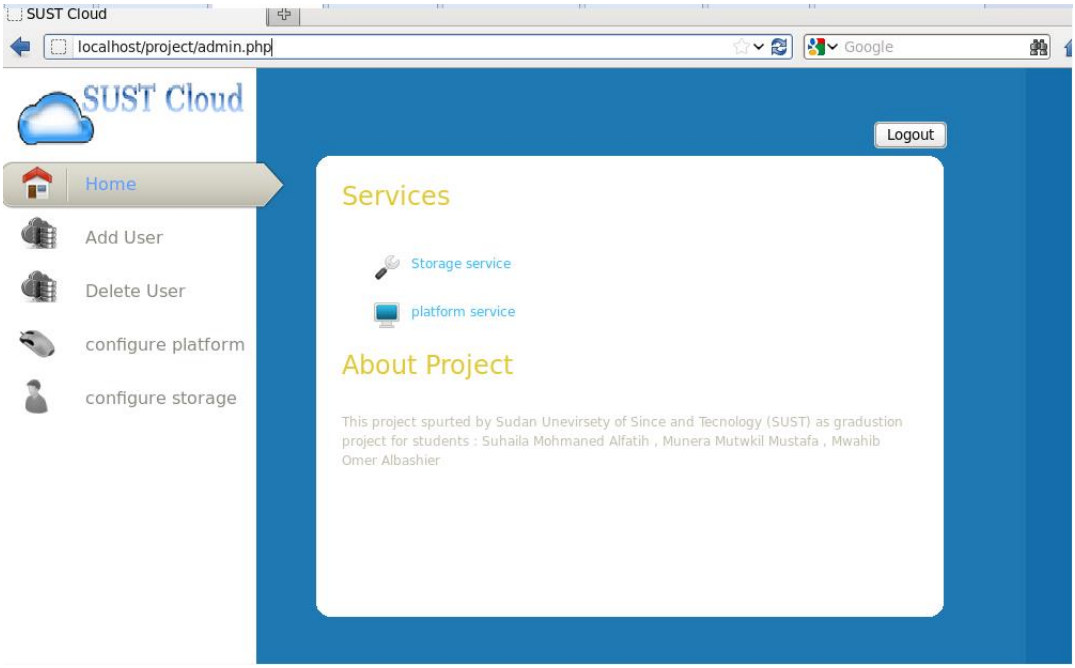
The next screen used for login to the cloud.



[Figure 5-1] Login page

5.3.1 Administrator Side

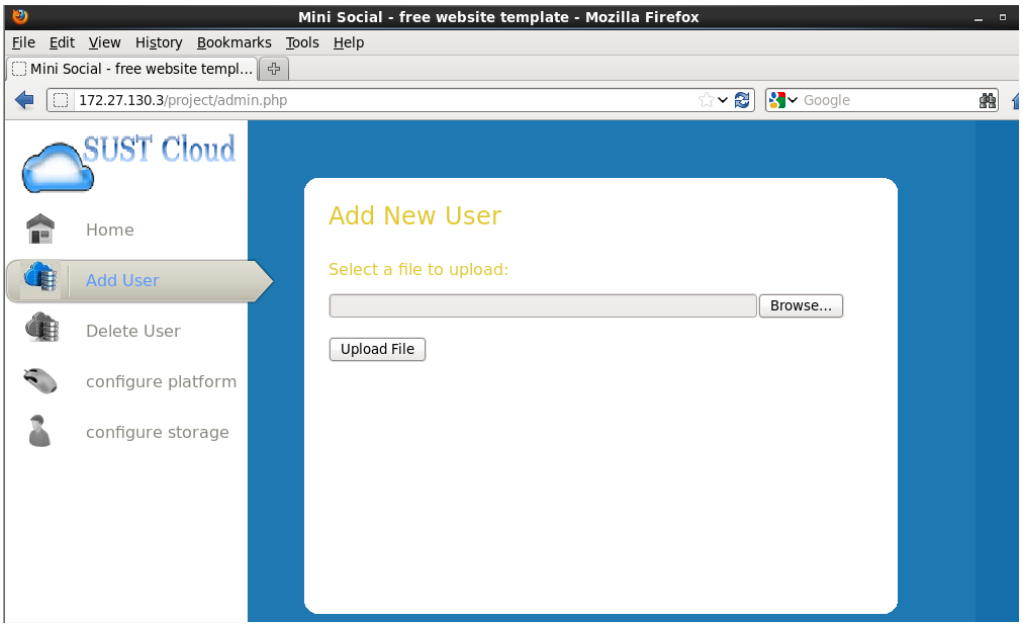
If the logged user is admin then the admin home page presented.



[Figure 5-2]Admin home page

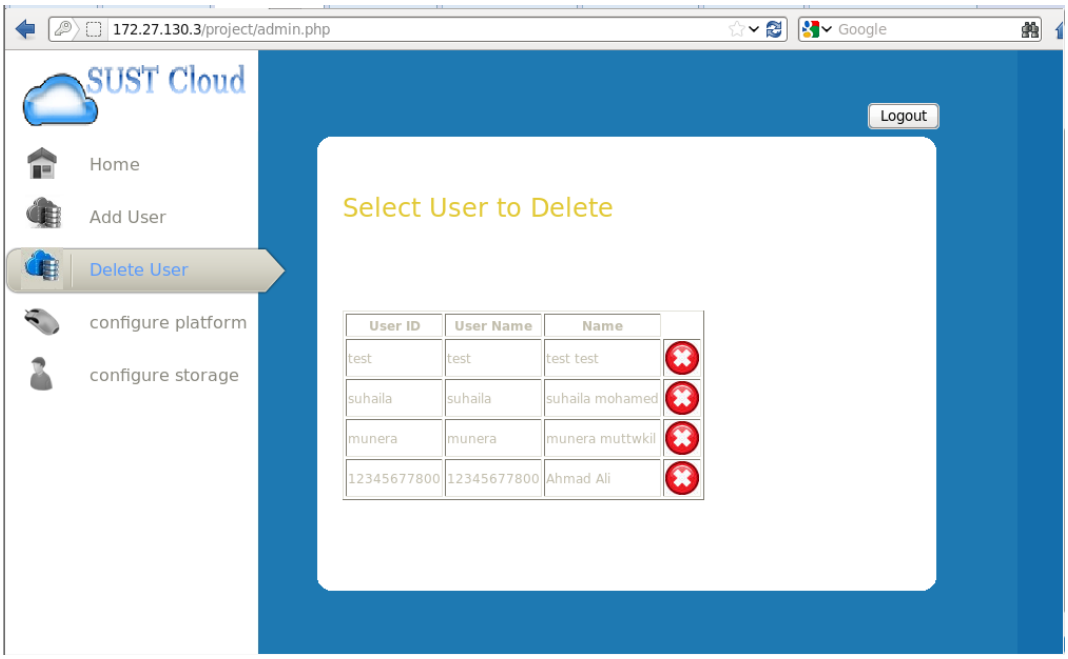
The admin has number of functionalities as shown in the next points:

When add user button selected then the following screen displayed and the admin can upload file contain the user id and the complete user name after that user can login with the id and password student.

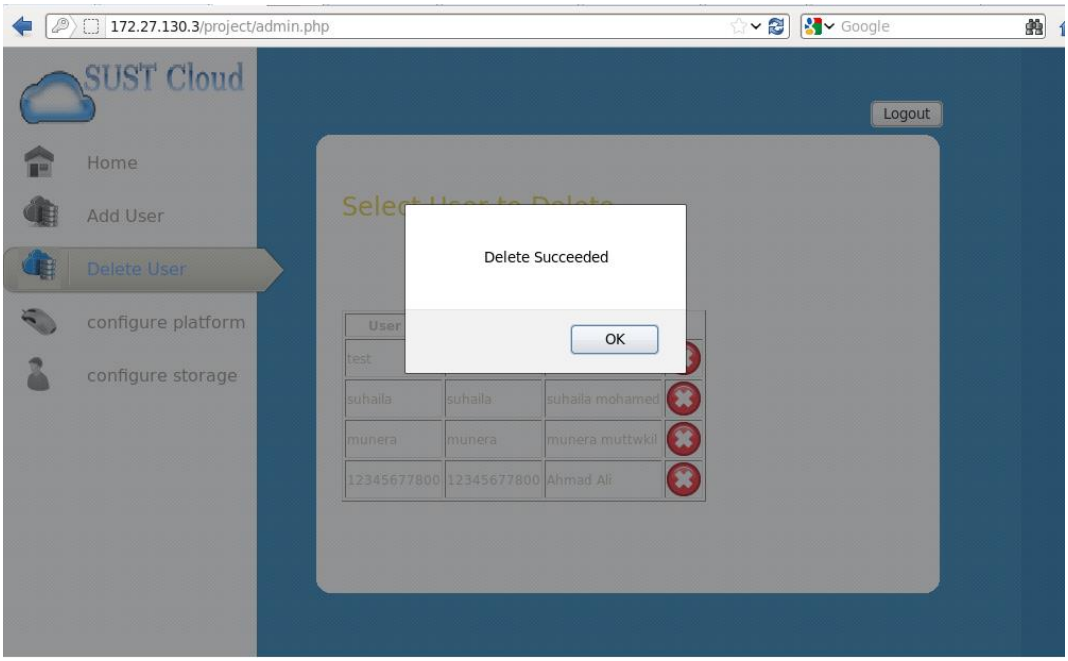


[Figure 5-3] Add user page

When the administrator click on Delete user the next screen presented which contain all users ,he can selects user which he want to delete from the system.



[Figure 5-4] Delete user page

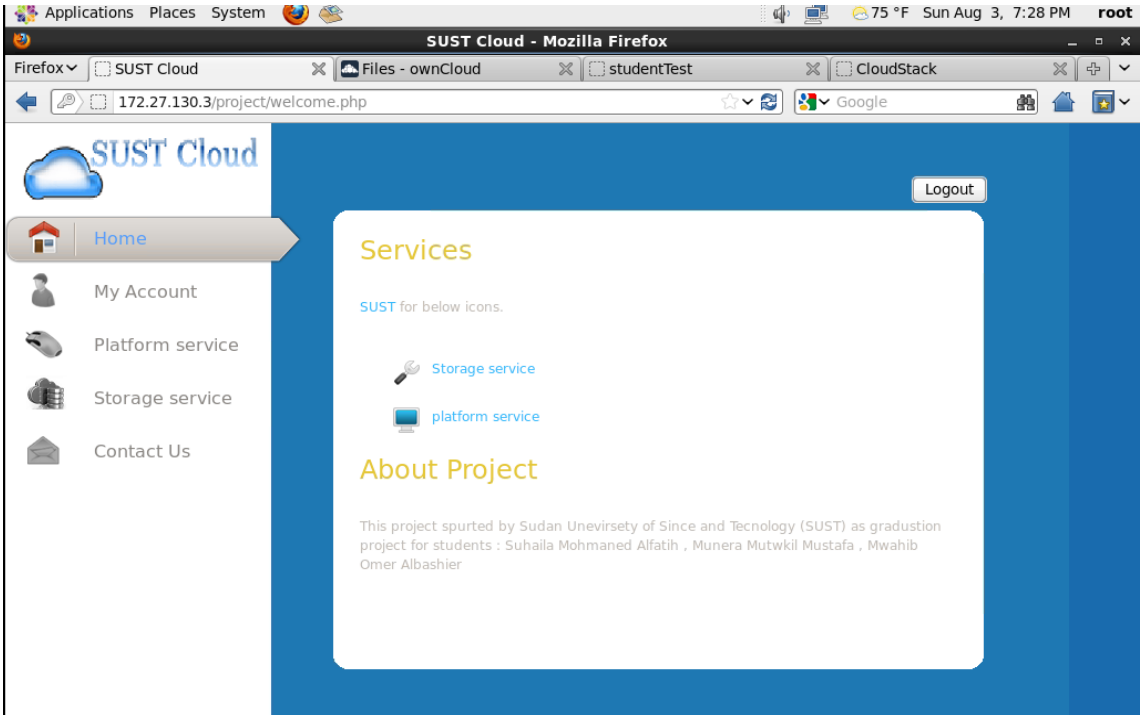


[Figure 5-5] Deletion successful

Furthermore the admin can login to the CloudStack UI to configure more platform services or OwnCloud UI to configure the storage service by click on configure platform service or configure storage.

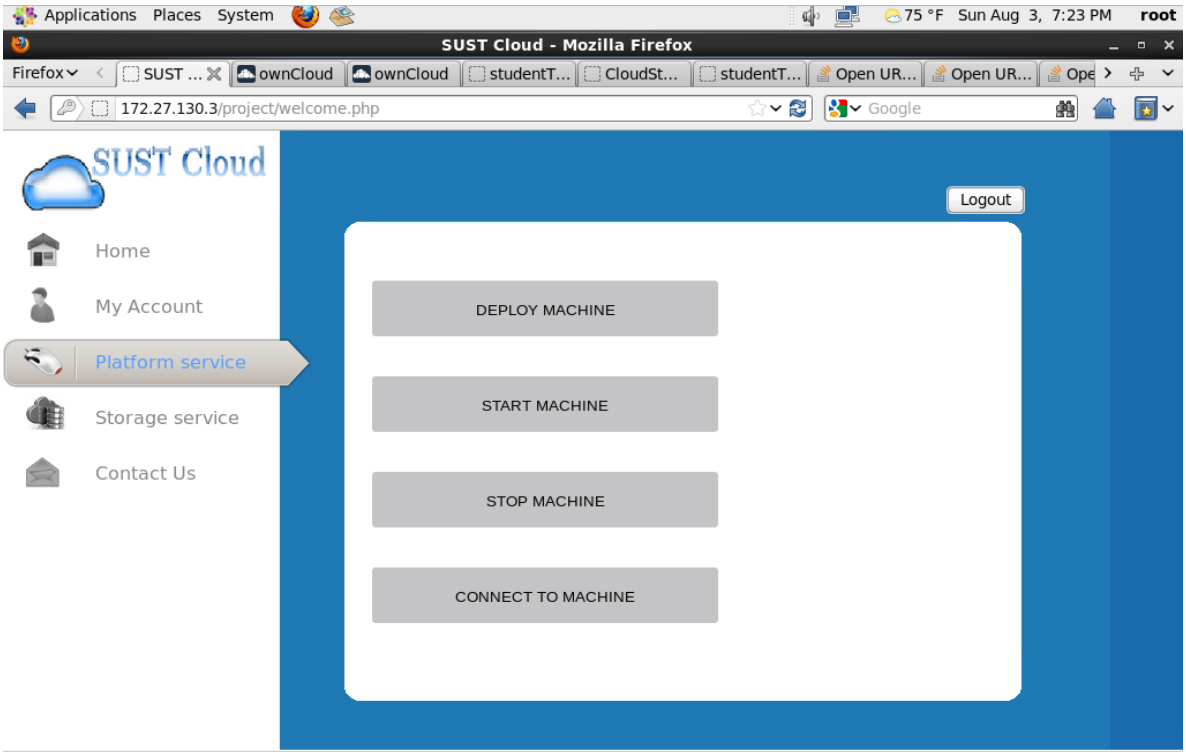
5.3.2 User Side

User home page after login.



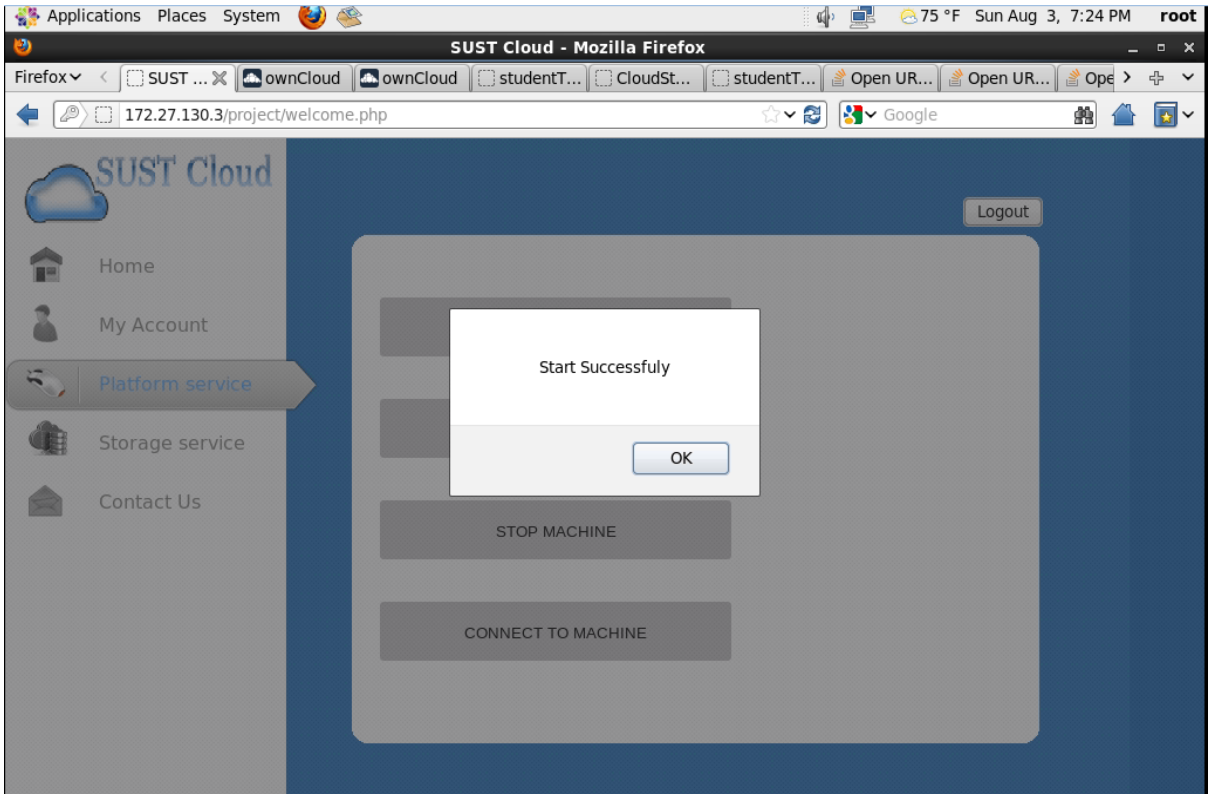
[Figure 5-6] User home page

When user click on platform service this service provides virtual machine include windows to enable the users to deploy java programing.



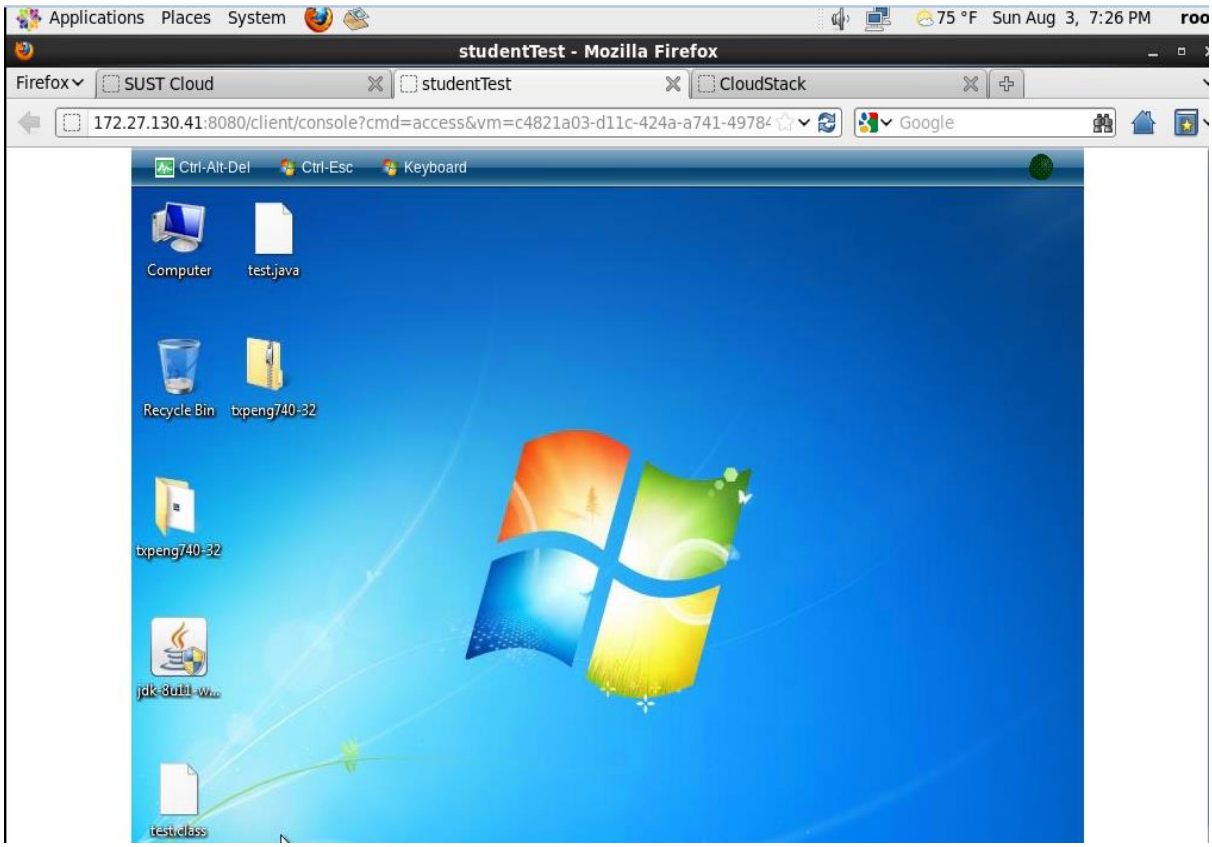
[Figure 5-7] Platform service

When user click over start machine, VMware lunched and he can connect to it.



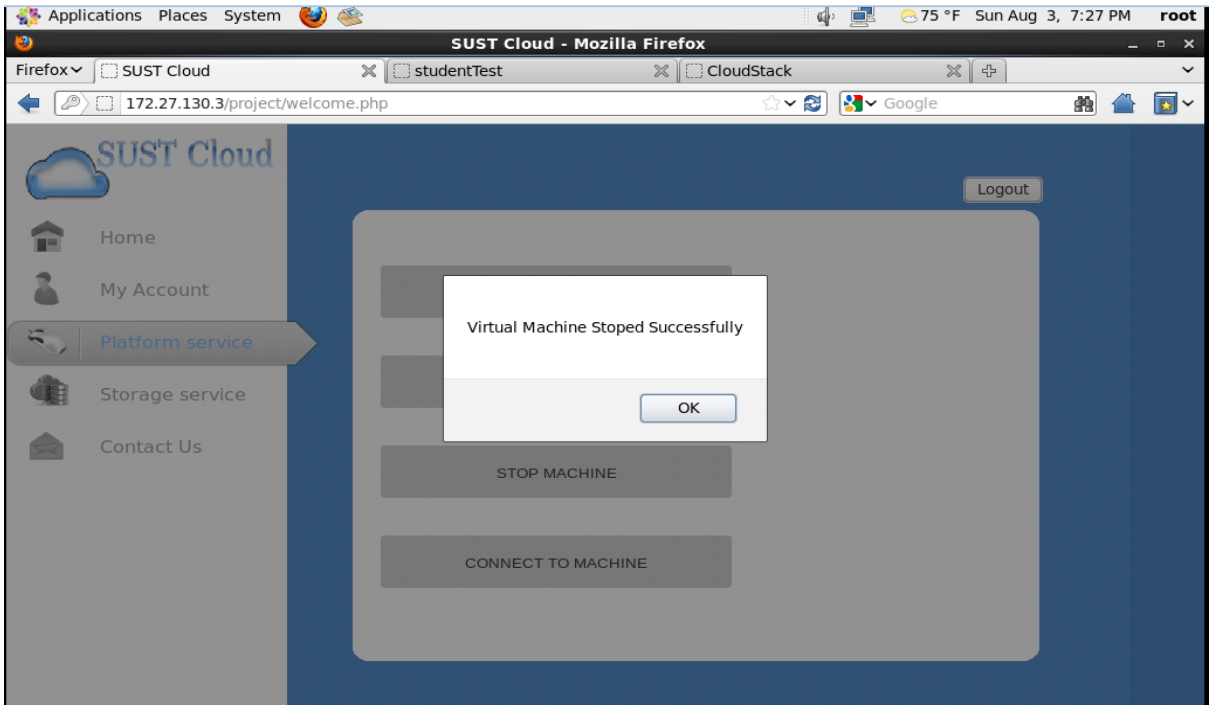
[Figure 5-8] Start machine

After start machine to connect for this VMware should be click over connect to machine, after that he can use the java tools to deploy java applications.



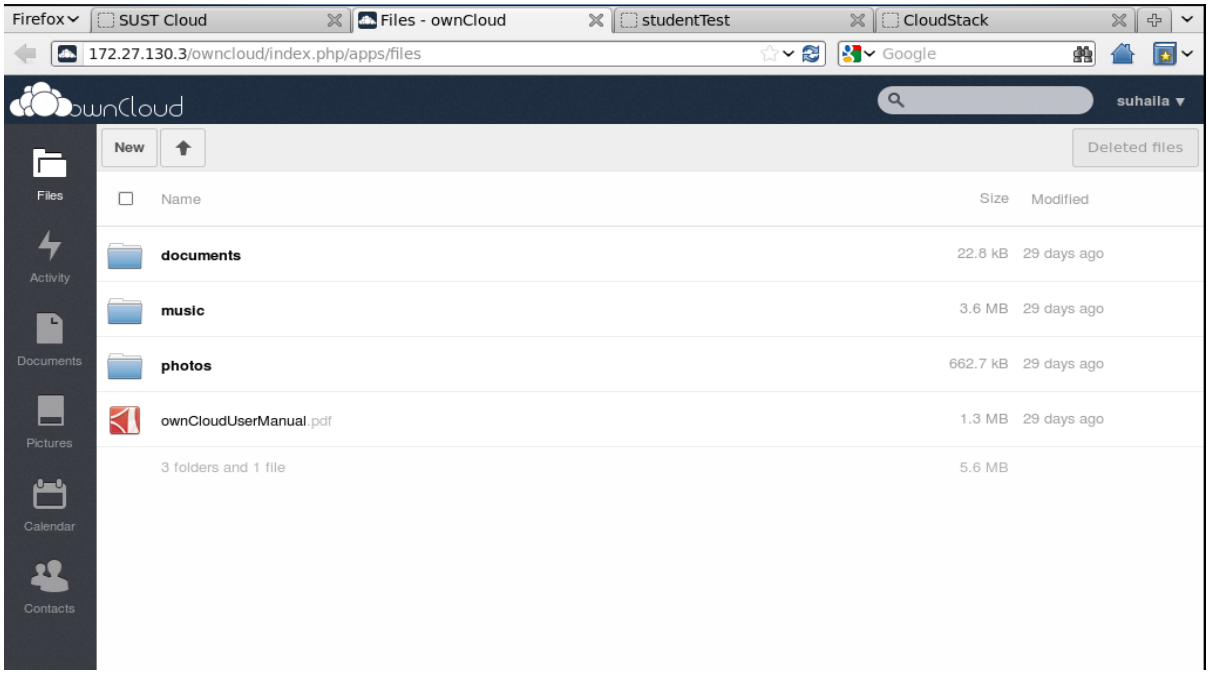
[Figure 5-9]User connect to his machine

If user want to stopping machine should be click over stop machine, and he can see massage show this process done or not.



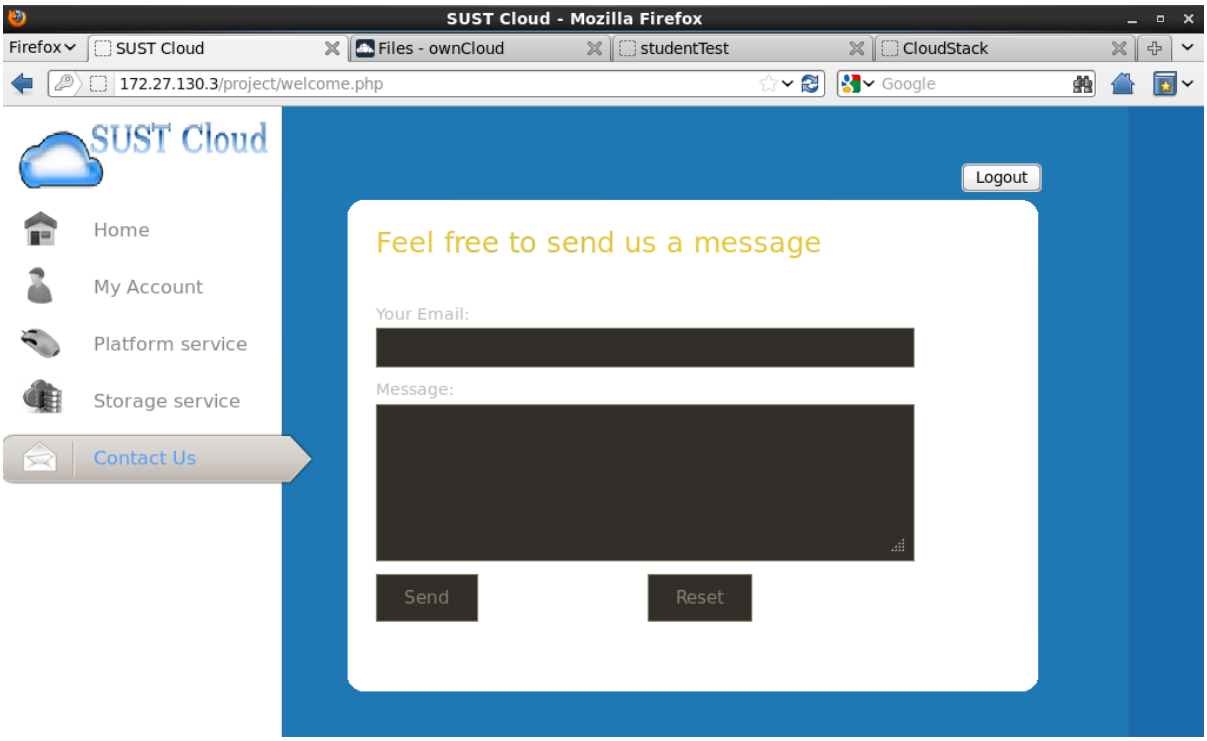
[Figure 5-10]User stop his machine

User home page to upload or downloads files from any types.



[Figure 5-11]Storage service

This screen enables the users to contact administrator to report for any problem or suggestion to enhance this project.



[Figure 5-12]Contact us

CHAPTER 6

RESULTS AND RECOMMENDATIONS

PAGE (33)

6.1 INTRODUCTION

This chapter discusses the results, recommendations and the obstacles which faced the project.

6.2 CONCLUSION

A private cloud environment has been offered for users in the college CSIT, two of the desired services work as expected (PaaS and Storage as a service).

The aim of project was decrease the time and cost of the installation and maintenance of the software which achieved by the cloud as it offer template contain preconfigured software ready to use, and it reduce the needing for use external storage devices by offering cloud storage spaces, and both services can accessed through the HTTP protocol from any place at any time .

6.3 RECOMMENDATION

We recommends with the following:

- Implements the software as a service model.
- Expand this system to include all collages in SUST.
- Enhance overall system security.
- Embed smart monitoring option using android and smart phones to monitor the cloud.

6.4 OBSTACLES:

The implementation of this research faced many problems:

- Delay in providing required resources.
- Before the resource availability several configuration attempt has been done:
  - Ubuntu was used to build cloudStack from the source which was failed many times because the deps files were not found.
  - Then Migrate to CentOs, the setup of management server was successfully done, but the hypervisor fail because the software was incompatible with CPU architecture.
- The server which provided was outside the university and the accessibility was done through remote access, furthermore the server was not available most of the time.

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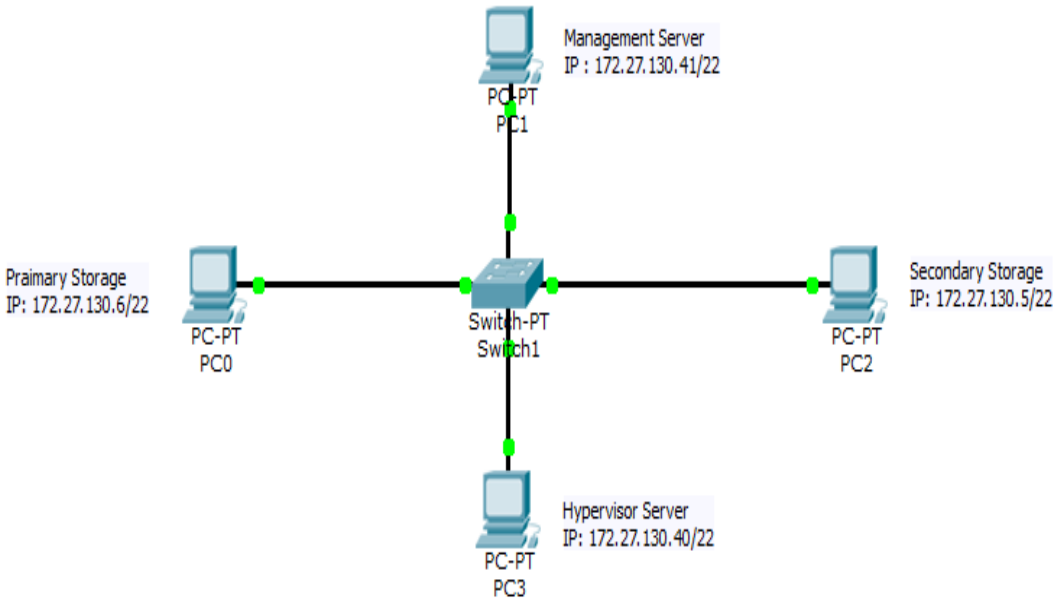
APPENDIX I

Cloudstack configuration



[Figure APPINDEX 1] Cloudstack component

1-Management server installation

Install the centOS 6.3 64 bit.

- Login to the system as root to get all the permission of the system.
- Check for a fully qualified hostname
- Make sure that the machine can reach the Internet.
- Configure package repository :

  A repository is a package source that contain list of packages-versions, by default all packages repository in centos allocated in /etc/yum.repos.d

Creating a yum repo touch /etc/yum.repos.d/cloudstack.repo

- Configuring your systems to use your new yum repository

```
vi   /etc/yum.repos.d/cloudstack.repo
append :
[apache-cloudstack]
name=Apache CloudStack                          #the name of repository
baseurl=http://cloudstack.apt-get.eu/rhel/4.0/   #the url of repository
enabled=1
gpgcheck=0
```

- Turn on NTP for time synchronization:

```
yum install ntp
```

The yum is an open-source command-line package- management utility for Linux operating , it require internet connection to allow automatic updates, package and dependency management.

- Install all the required packages from cloud stack repository :

```
yum install cloud-client                        #download all cloudstack packages.
```

- Downloading vhd-util and copy it into /usr/lib64/cloud/common/scripts/vm/hypervisor/xenserver
- Install the database server to store template and user data.

```
yum install mysql-server
    service mysqld start                        #start the database server
mysql_secure_installation
```

- Setup the database table that cloud stack will use to store the user data:

```
#cloud-setup-databases:command supported by cloudstack
#Table name: Cloud
#Deploy by the user: root
#The root Password:123456
cloud-setup-databases cloud:dbtest@localhost \
--deploy-as=root:123456
```

- Configure the Security Policies

```
vi /etc/selinux/config
set :
SELINUX=permissive
```

Security-Enhanced Linux (SELinux) is a Linux kernel security module that provides the mechanism for supporting access control security policies it can be one of three options :

Enforcing mode SELinux policy will be enforced and is used in production systems.

- Permissive mode is used for debugging and policy development.
- Disabled mode SELinux policy will not be enforced [21].

2- Primary storage NFS Server:

NFS is the Red hat service for sharing files and printers on a directory with Linux and Unix computers we share two directories primary and secondary to use by the management server and hypervisor [22].

- Install the centOS 6.3 64 bit.
- Login to the system as root to get all the permission of the system.
- Check for a fully qualified hostname.
- Download nfs utility.

```
yum install nfs-util  #download nfs required packages
mkdir -p /export/primary
vi /etc/exports
Add the following line :
        /export  *(rw,async,no_root_squash)     #  * indicate any one can request the shared
                                                                                                file.
                                                                # rw the permission of access to the sheared
                                                                                        is read and write.
                                                                # no_root_squashallows the root user on
                                                                  the client to access/create files on the NFS
                                                                                                server as root.
          exportfs–a                                                  #Exports the shared files in /etc/exports to
                                                                                                the system.

                                                                  Reboot                        #reboot the system.
```

3- Secondery storage NFS server:

- Install the centOS 6.3 64 bit.
- Login to the system as root to get all the permission of the system.
- Check for a fully qualified hostname.
- The properties for hypervisor vm:

```
yum install nfs-util                          #download nfs required packages
mkdir -p /export/secondary
vi /etc/exports
Add the following line :
/export  *(rw,async,no_root_squash)      #  * indicate any one can request the shared
                                                                                    file.
                                                  # rw the permission of access to the sheared
                                                                    is read and write.
                                                  # no_root_squashallows the root user on
                                                    the clienttoaccess/create files on the NFS
server as root.
        exportfs–a                                    #Exports the shared files in /etc/exports to
                                                                                    the system.

                    Service nfs restart                                    #restart the service.
```

- Then stop the firewall :

```
service iptables stop
```

- Prepare the System VM Template we are going to use KVM as hypervisor

```
/usr/lib64/cloud/common/scripts/storage/secondary/cloud-install-sys-tmplt
-m /export/secondary -u http://download.cloud.com/templates/acton/acton-systemvm-
                                                                    02062012.qcow2.bz2 -h kvm
```

- Once all the package are available now we can setup CloudStack management server

```
cloud-setup-management
```

After this step the management user interface (UI) can be accessed but it was not able to appear after checking the log file in /var/log/cloud/setupManagement.log and /var/log/cloud/management/catalina.out we find that catalina.out need more permission:

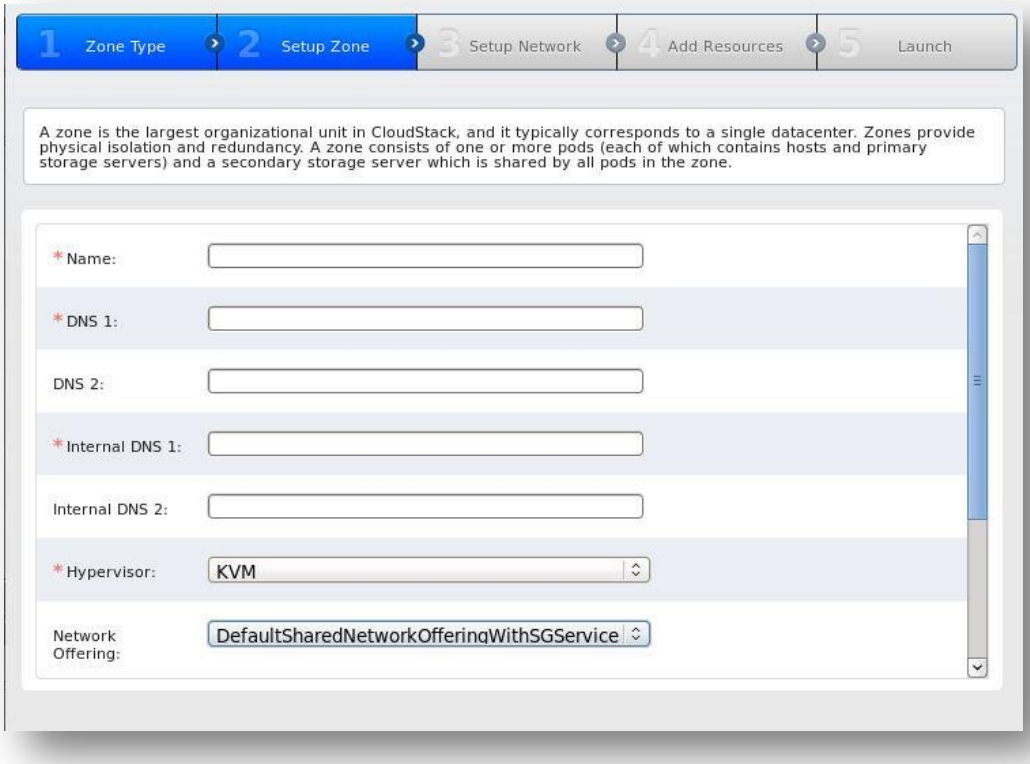
```
chmod 777 /usr/share/cloud/management/logs/catalina.out
```

Then the UI can be access from any browser using

```
http://172.27.130.41:8080/client
```

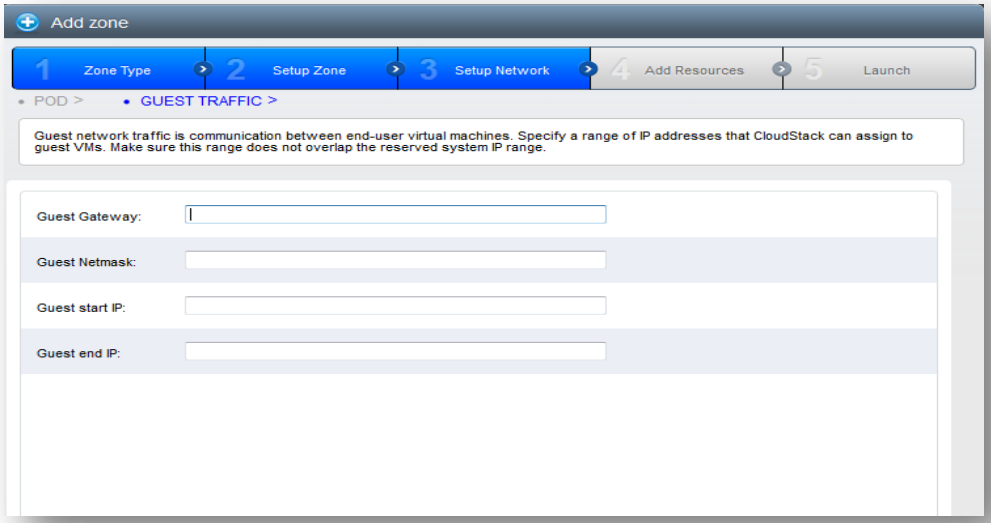
After that building cloud infrastructure has been done by creating the zone, pod, cluster primary and secondary storage:

Configure the zone :



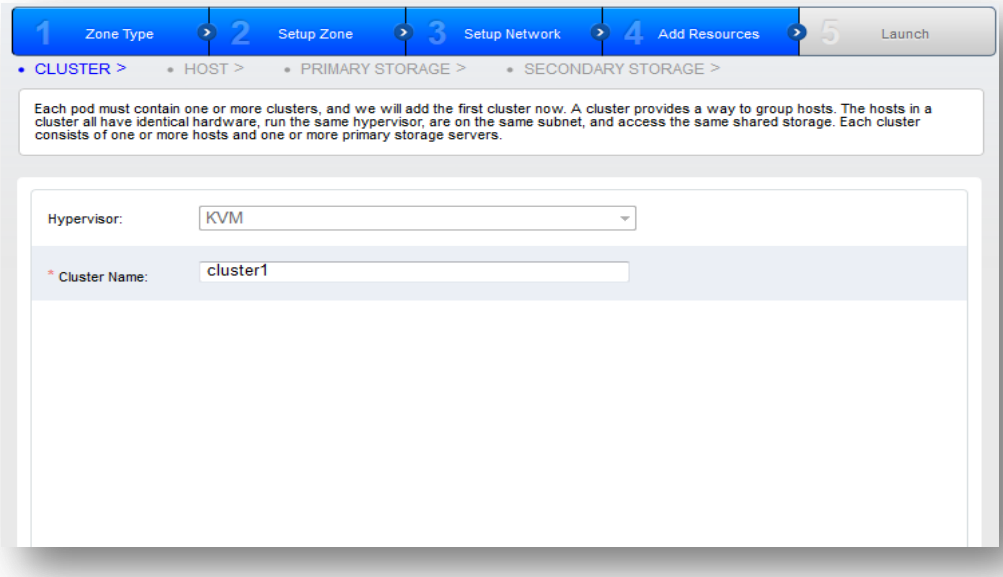
[Figure APPINDEX 2] Zone configuration

The guest network must configure by determine the range of IP addresses used for guest VMware's and the gateway IP address.



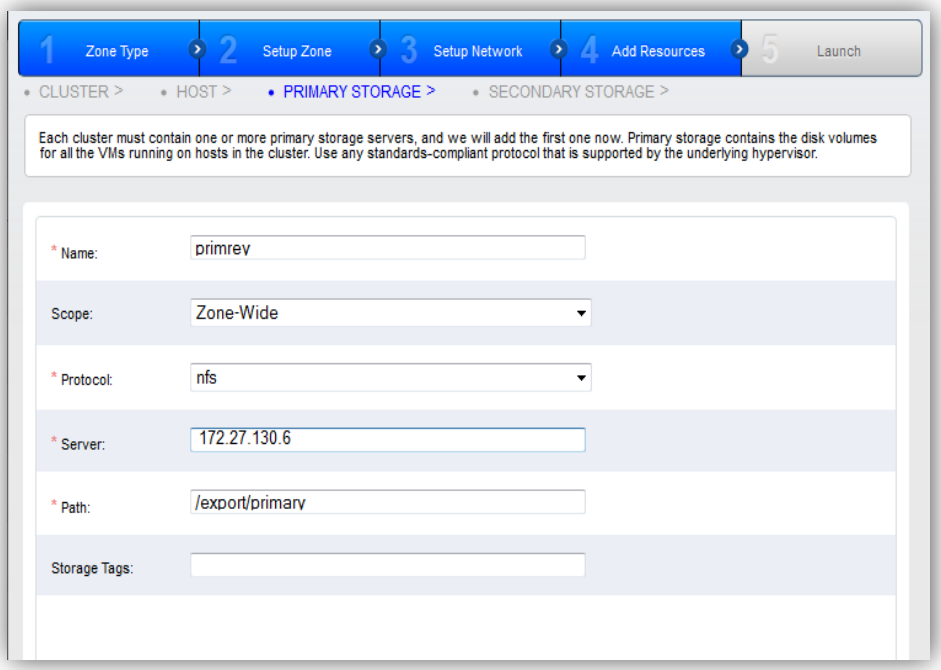
[Figure APPINDEX 3]Guest network configuration

Configure cluster which it contains pods and their associate storage by setting hypervisor type and the cluster name.



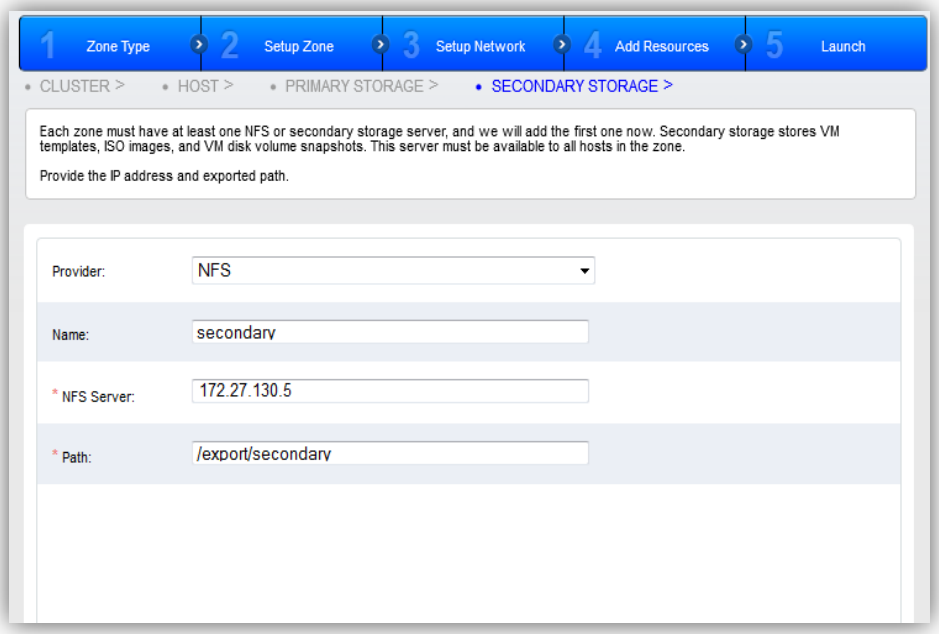
[Figure APPINDEX 4] cluster configuration

Configure the primary storage:



[Figure APPINDEX 5] primary storage configuration

Configure the secondary storage:



[Figure APPINDEX 6] secondary storage configuration

4- KVM hypervisor host installation:

Kernel based Virtual Machine(KVM) is virtualization solution for Linux that consist of loadable kernel module, itsupport multiple virtual machines running with Linux or Windows images, any virtual machine has private virtualized hardware: a network card, disk and graphics adapter. [23]

- Install the centOS 6.3 64 bit.
- Login to the system as root.
- Check for a fully qualified hostname
- Make sure that the machine can reach the Internet
- Configure package repository

```
Creating a yum repo
touch /etc/yum.repos.d/cloudstack.repo
```

Configuring your systems to use your new yum repository

```
vi   /etc/yum.repos.d/cloudstack.repo
append :
[apache-cloudstack]
name=Apache CloudStack
baseurl=http://cloudstack.apt-get.eu/rhel/4.0/
enabled=1
gpgcheck=0
```

- Turn on NTP for time synchronization

```
yum install ntp
```

- We start by installing the required packages:

```
yum install cloud-agent
```

- Install and configure libvirt which is a toolkit to interact with the virtualization capabilities in Linux hear it used to manage the virtual machines. [24]

```
vi /etc/libvirt/libvirtd.conf
Set the following paramaters:
listen_tls = 0                  #stop the transport layer security (tls) socket.
listen_tcp = 1                  #listen on TCP/IP connections.
```

```
tcp_port = "16059"                    #listen on the port 16059 for tcp
connection.
auth_tcp = "none"                     #indicate that we use unencrypted TCP/IP
socket
mdns_adv = 0                          #disable local discovery of libvirt hosts via
multicast-DNS.
vi /etc/sysconfig/libvirtd
Uncomment the following line:
#LIBVIRTD_ARGS="--listen"             #start the server in listening mode
service libvirtd restart              #restat the libvirt service
```

- Configure the Security Policies

```
vi /etc/selinux/config
                                                                    set :
                                                        SELINUX=permissive
                                                        setenforce permissive
```

- Configure the network.

```
Vi /etc/sysconfig/network-scripts/ifcfg-eth0
DEVICE=eth0
HWADDR=00:0C:29:90:23:2D
ONBOOT=yes
HOTPLUG=no
BOOTPROTO=none
TYPE=Ethernet
```

- Setup network bridges:The network bridge used to connect two independent network segments at layer two levels,hear this point it used to forward traffic to instances running on KVM.

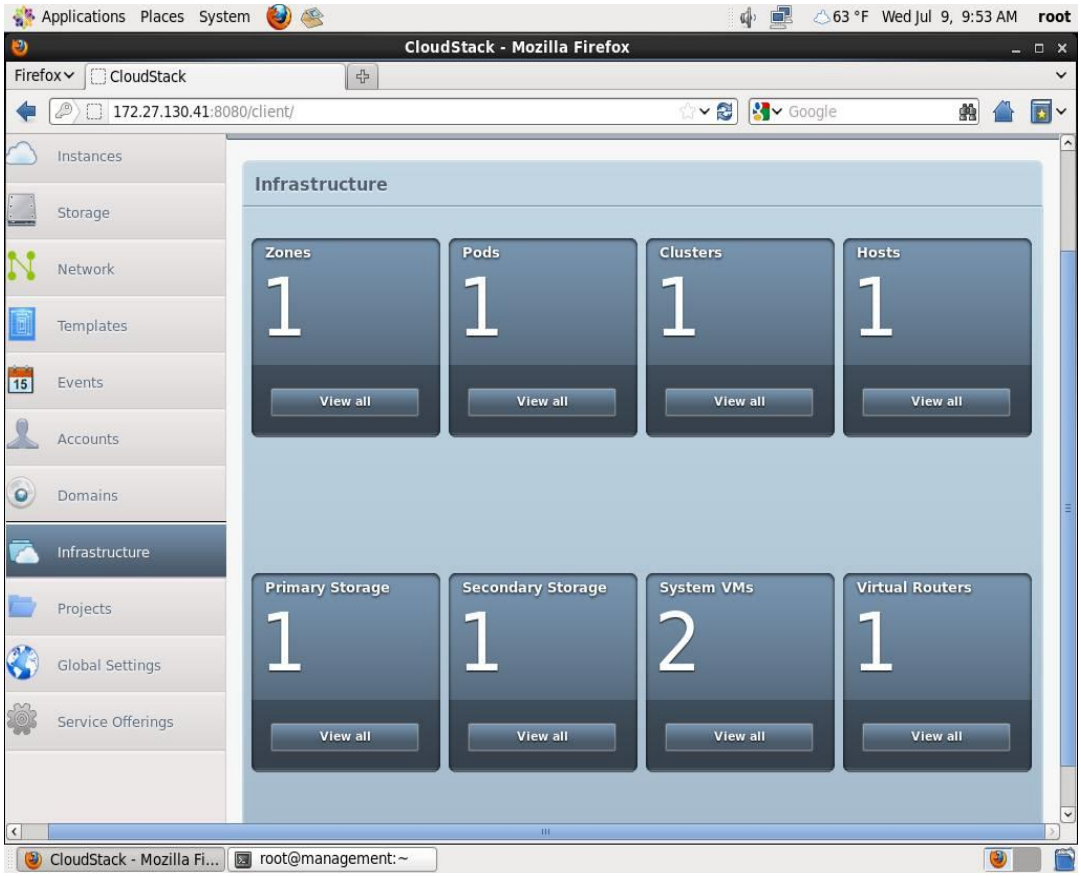
```
DEVICE=cloudbr0
TYPE=Bridge
```

```
IPADDR=172.27.130.41
NETMASK=255.255.252.0
ONBOOT=yes
BOOTPROTO=none
NM_CONTROLLED=no
DELAY=0
```

- Add the host to CloudStack

Cloud-setup-agent	#add the KVM host to cloudstack infrastructure

- Next screen show the infrastructure of the cloud after successfully setup of component



[Figure APPINDEX 7] cloud Infrastructure

5-Hardware specifications:

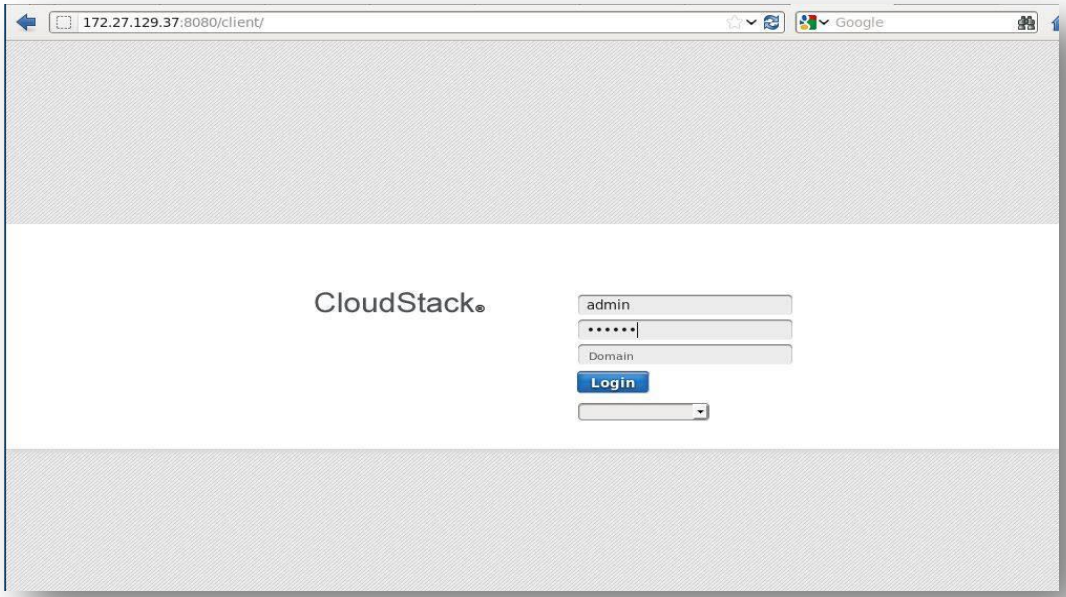
All the above steps were done using one server with the followings Specifications:

- 24 GB RAM.
- 64 bit processor.
- Virtualization technology enabled in the BIOS.

- The OS and all required packages installed using VMware.

cloudStack login screen for administrator

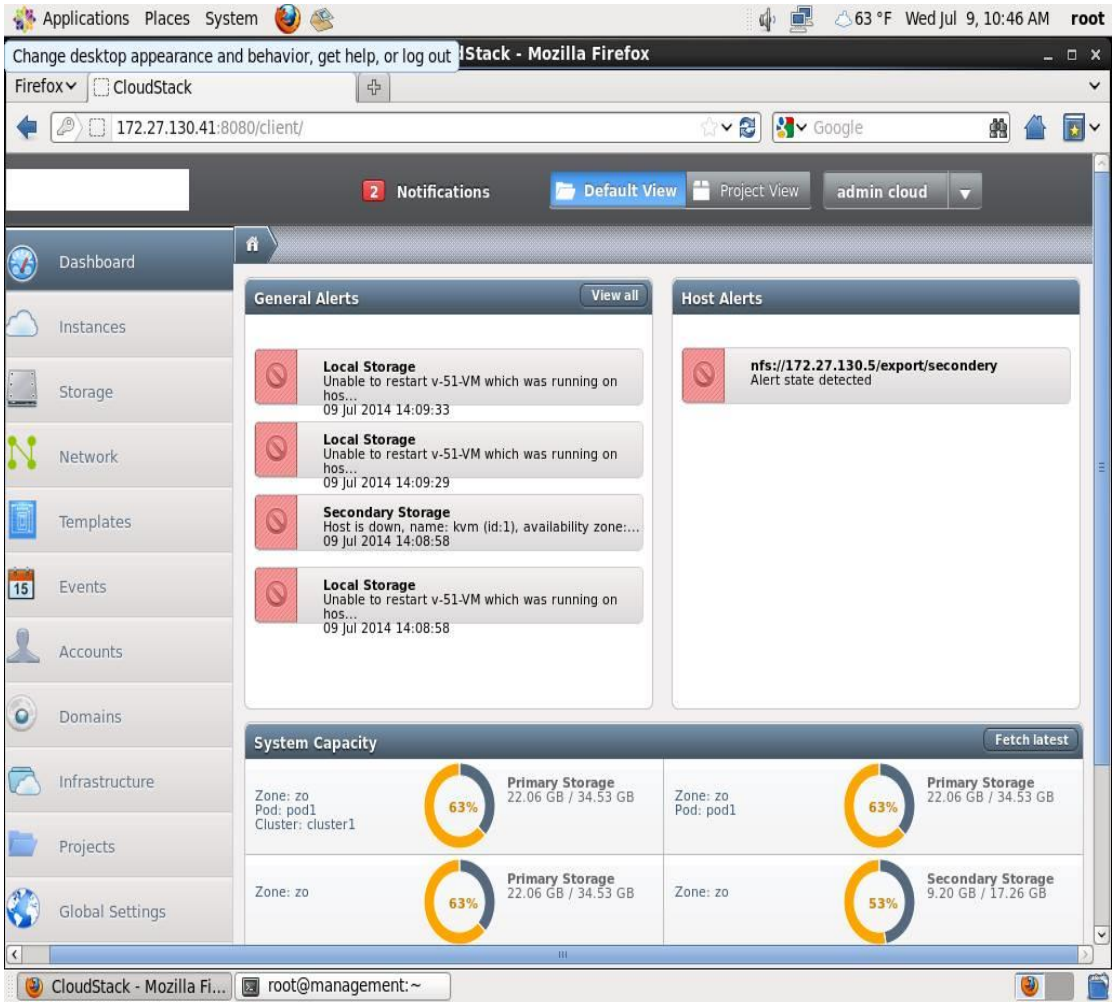
Administrator inserts his id and password then press login button.



[Figure APPINDEX 8] cloudstack login screen

Administrator dashboard

Dashboard screen appear after login success and it includes cloud status such as CPU and memory and the connectivity between system servers.

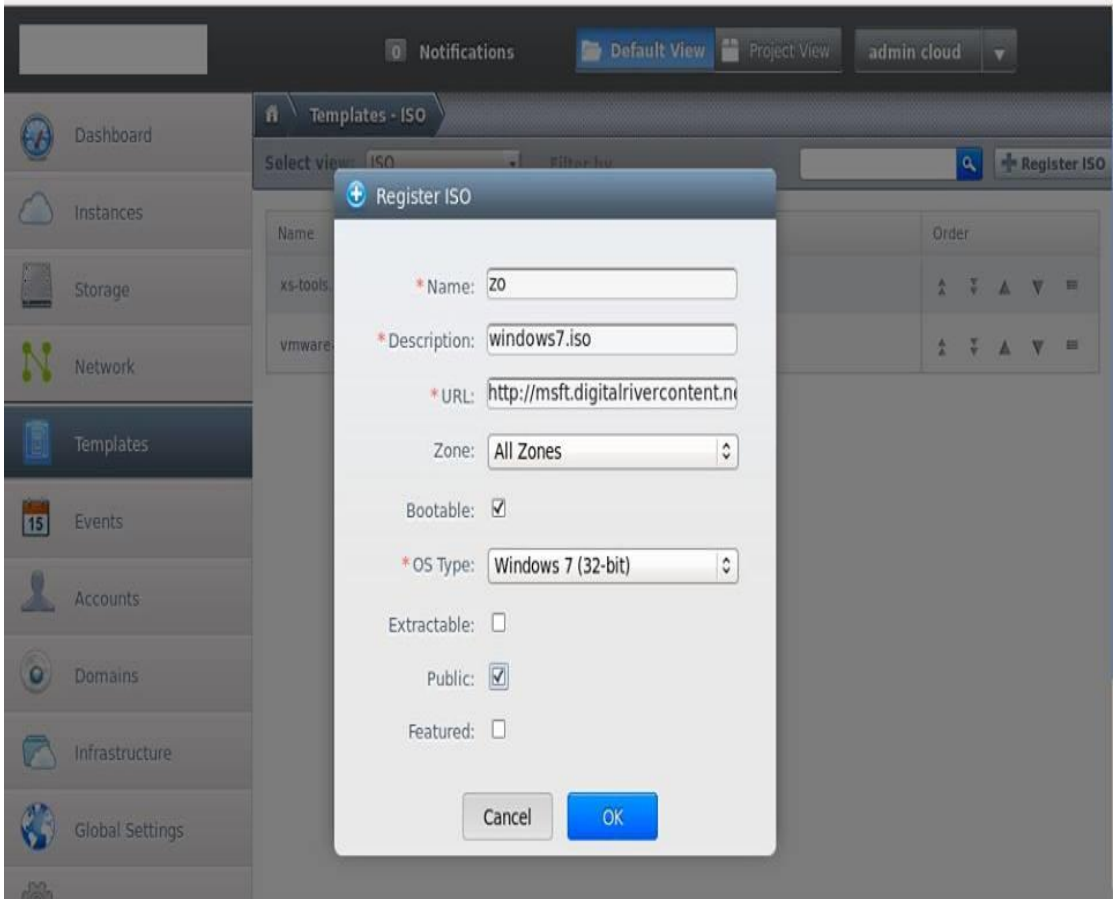


[Figure APPINDEX 9] Administrator dashboard

Register ISO into cloud

The flowing screen use to add iso on cloudstack by set several parameters: iso name, description, url that involve web page address to download iso, OS type and other information as option.

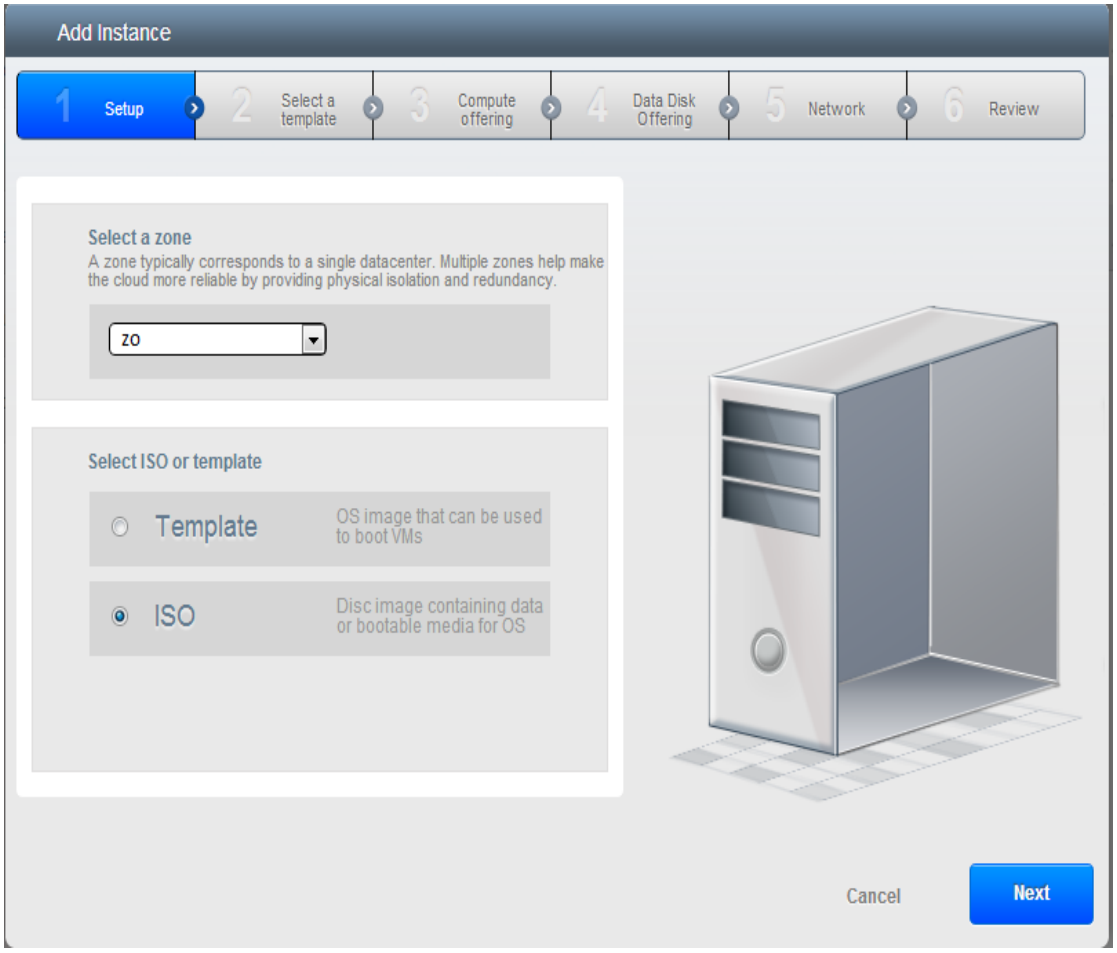
.



[Figure APPINDEX 10] Downloading ISO screen

1.1.1.1 Creating Instance

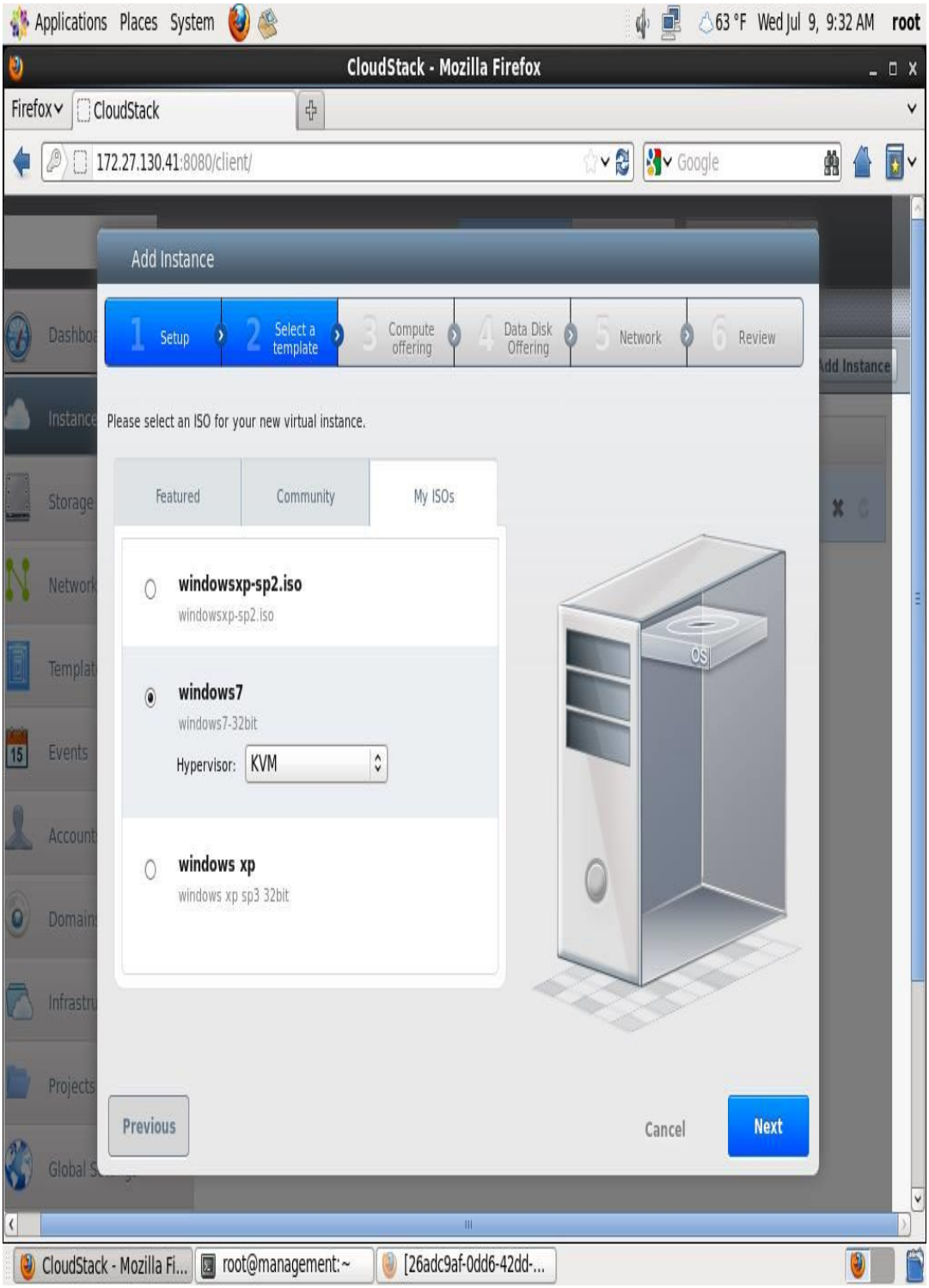
Administrator in this step chooses create instance form ISO.



[Figure APPINDEX 11] Creating instance

The Selecting of ISO

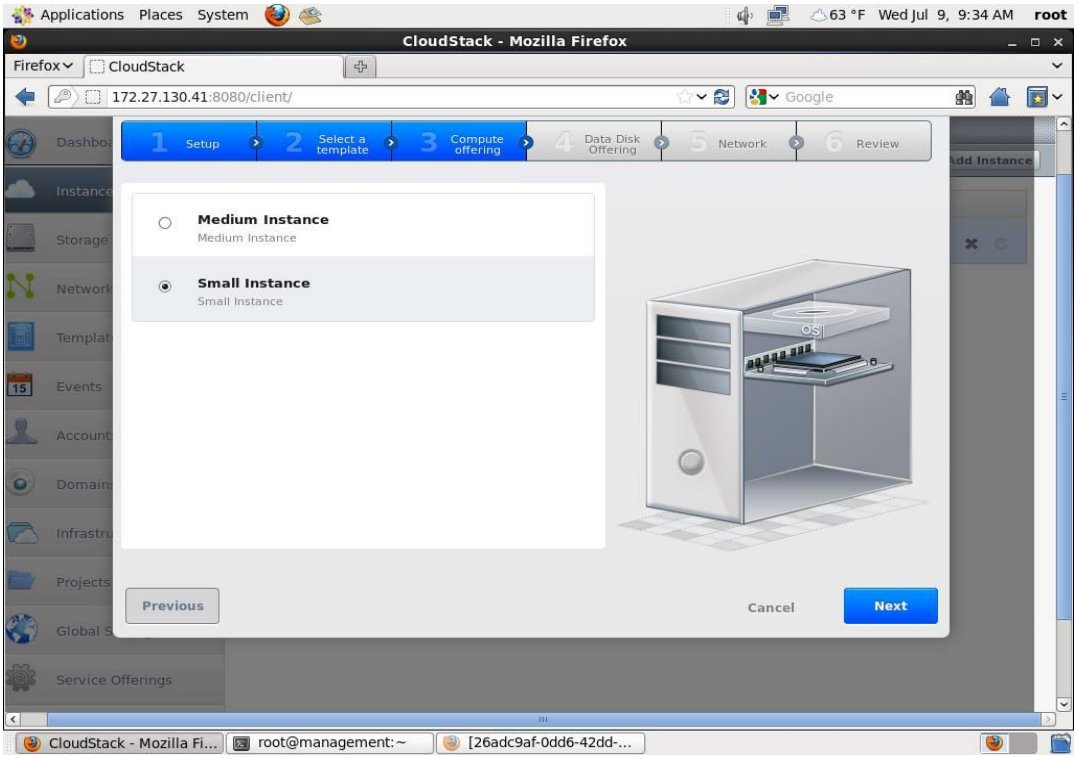
ISO selected for new virtual instance and chose the hypervisor type.



[Figure APPINDEX 12] Selected ISO

The selecting of compute offering

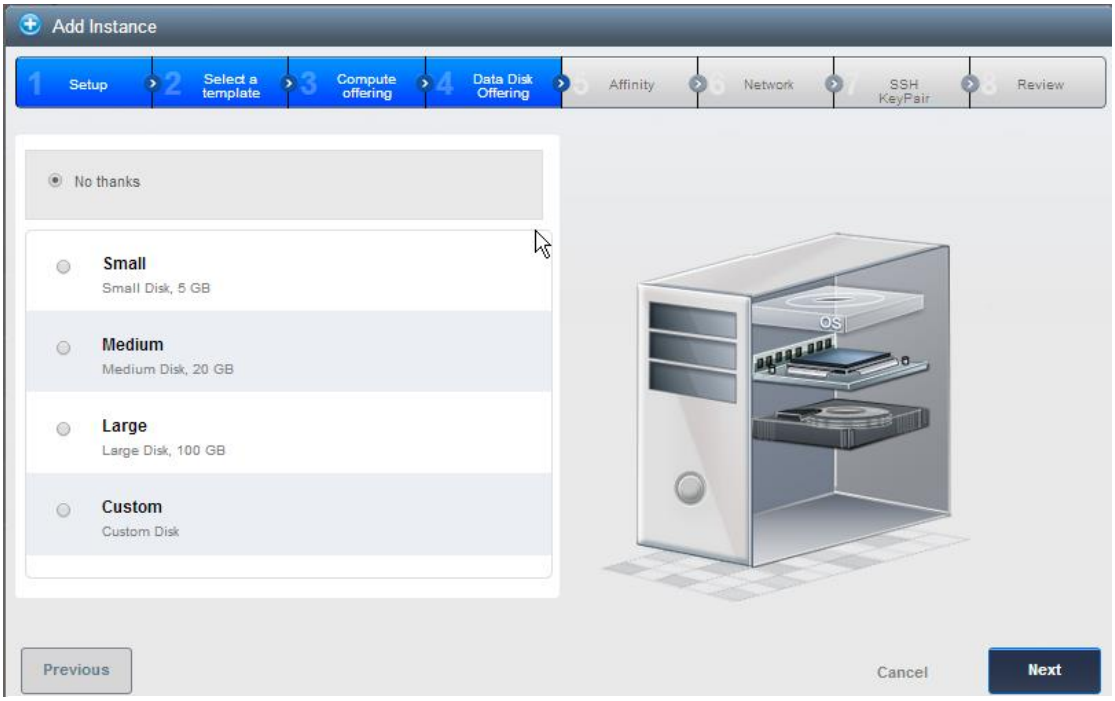
This step shows the process to choose the size of instance.



[Figure APPINDEX 13] compute offering

The selecting of disk offering

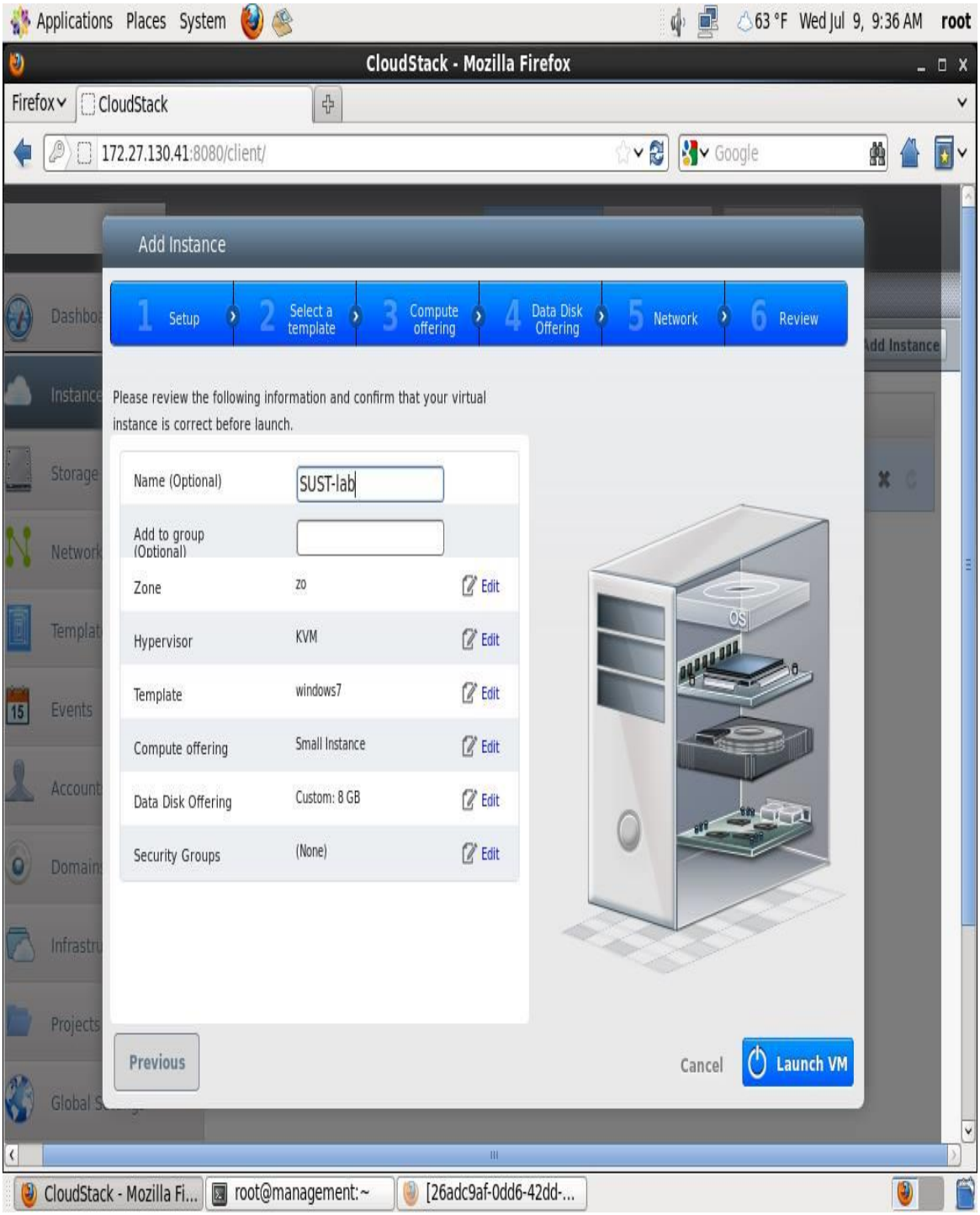
This step shows the process to choose the disk size for the instance.



[Figure APPINDEX 14] Determine compute offering

Setting instance name and show others information

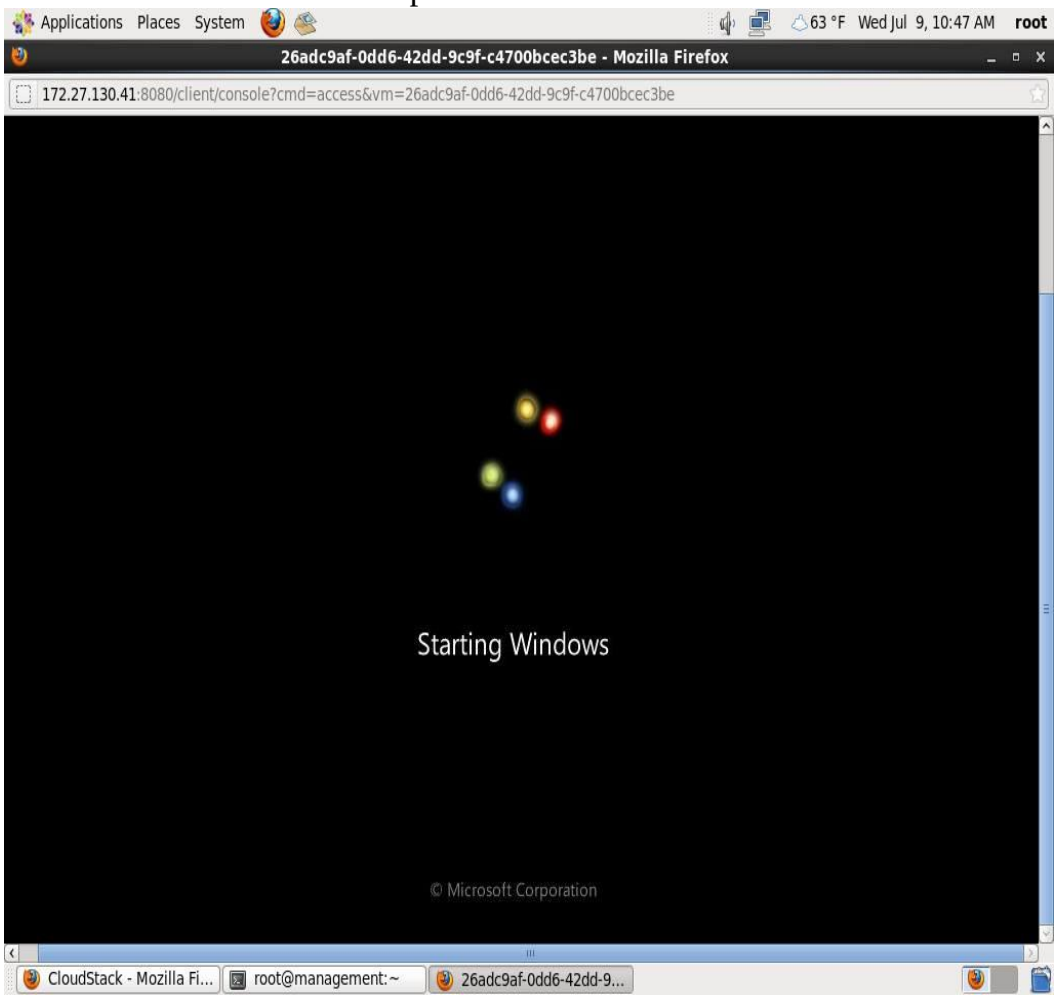
Administrator insert instance name, and add the instance to group as option, in addition he can edits the other information then click lunch button.



[Figure APPINDEX 15] Lunching of instance

Using the instance

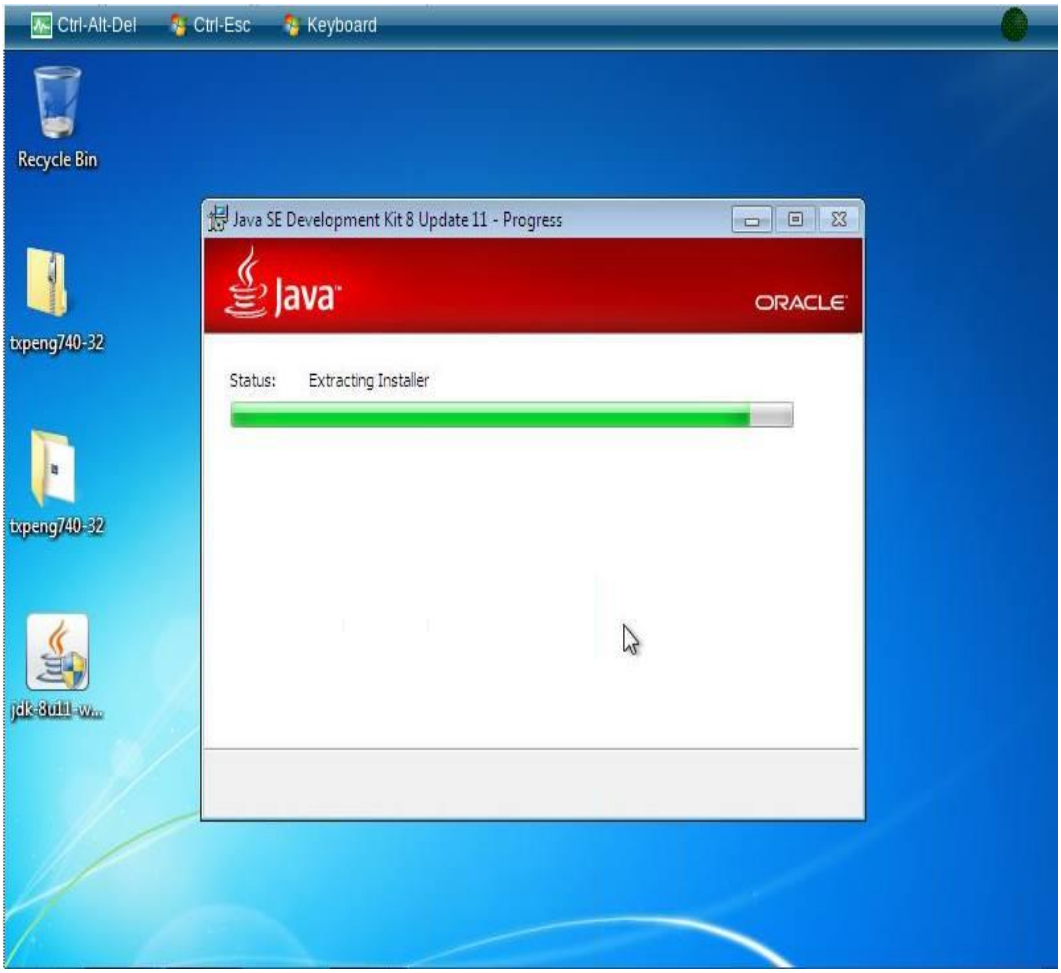
The next step after create instance completed is open instance and install the OS and here it is windows 7 then open it.



[Figure APPINDEX 16] Using instance

Java tools installation

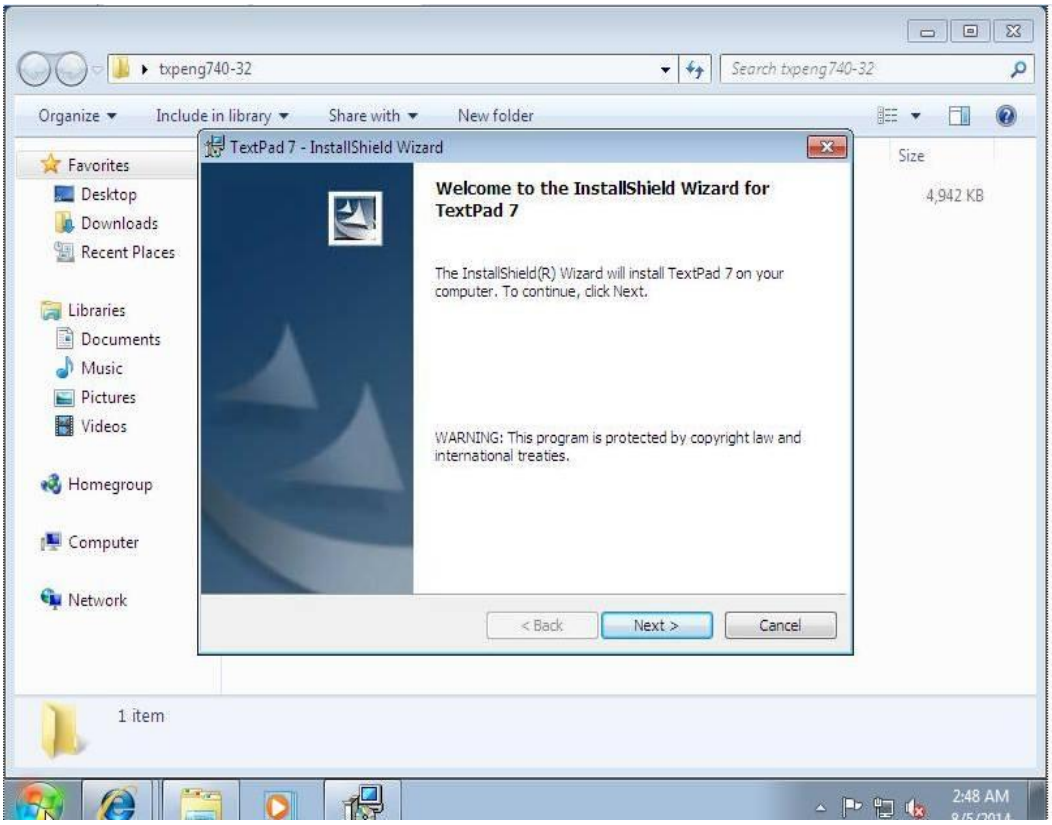
Administrator downloads java tools and installs it in windows 7.



[Figure APPINDEX 17] Install java

Textpadeditor installation

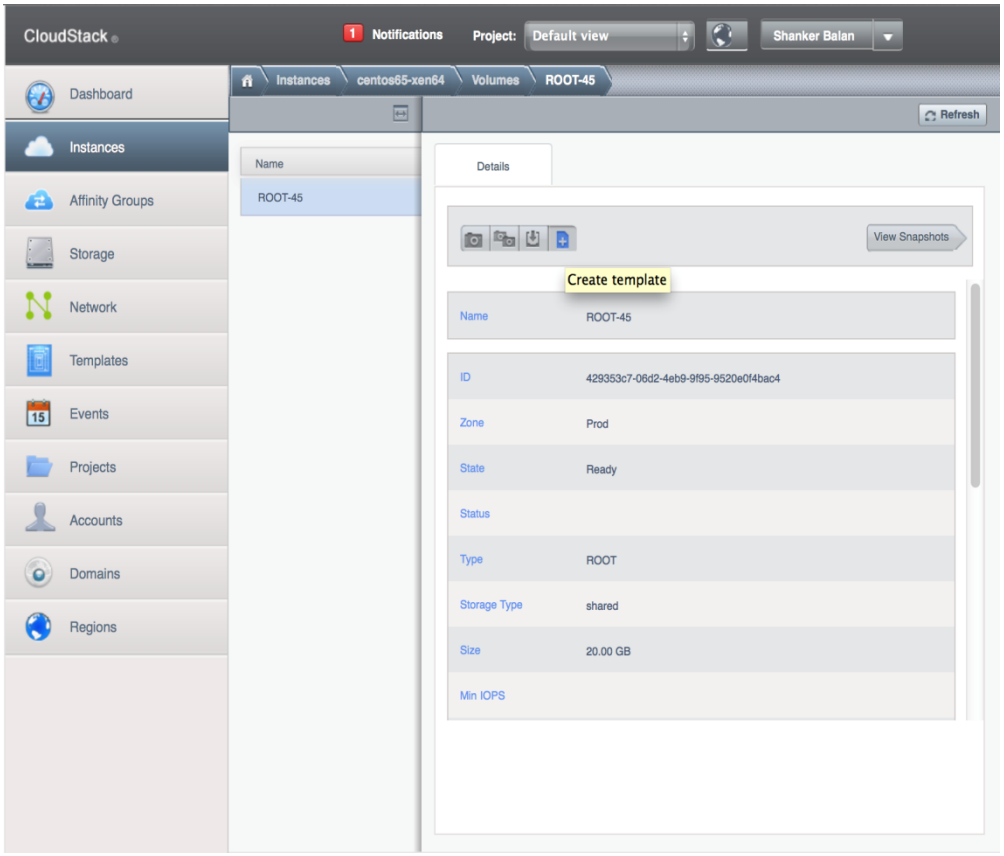
Administrator downloadsTextpad editorand installs it in windows 7.



[Figure APPINDEX 18] Textpad installation

Template creation

Administrator stops instance after installing the pervious tools and then creates template from this instance root volume.



[Figure APPINDEX 19] Template creation

APPENDIX II

ownCloud Installation

- Install necessary PHP extensions as fallowing:

```
yum install php-mysqlphp-jsonphp-xml php-mbstringphp-zip php-gd curl
                                                    php-curl php-pdo
```

- Setting up database for ownCloud:

  In this steps new database created for ownCloud and new table and user is created in it and that as fallowing:

```
mysql -u root –p                # login into mysql server using root user

Enter password:                 # Insert mysql server password

CREATE DATABASE owncloudb;    # create new database for ownCloud.

GRANT ALL ON owncloudb.* TO owncloduser@localhost
IDENTIFIED BY 'centos';                    #create user = owncloduser and
give him password = centos.

flush privileges;                #applying changes in database.

exit #exit from mysql server .
```

- Switch to apache root folder and download ownCloudversion 6.0.0:

```
wgethttp://download.owncloud.org/community/owncloud-6.0.0a.tar.bz2
```

- Extract the tar package using command:

```
tar xvf owncloud-6.0.0a.tar.bz2
```

- Move the extracted folder to the apache root folder .

```
mv owncloud/ /var/www/html/
```

- Set the ownership and permissions to the following folders:

```
chown -R apache:apache /var/www/html/owncloud/
chmod 777 /var/www/html/owncloud/config/
```

- Enable apache rewrite mode.
- Edit file **"**/etc/httpd/conf/httpd.conf",

```
vi /etc/httpd/conf/httpd.conf
```

- Find the following section and Change AllowOverride None to AllowoverrideAll.

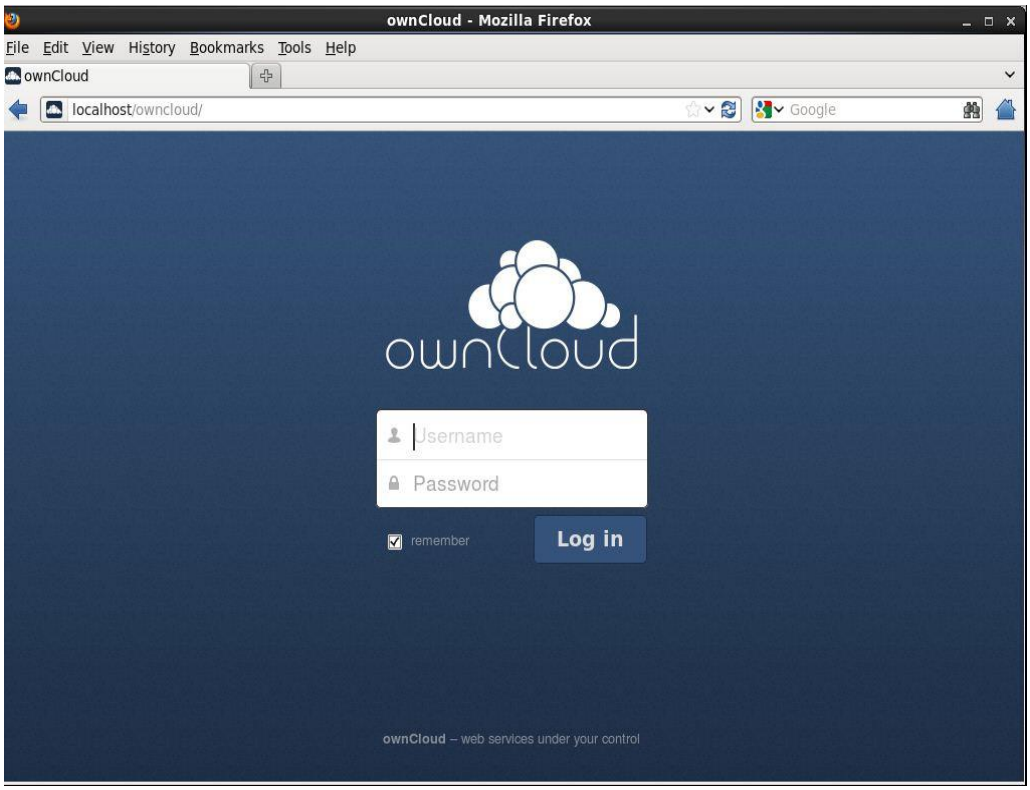
```
[...]
AllowOverride All
[...]
```

- Finally, restart the apacheand mysql services.

```
service mysql restart
service httpd restart
```

Login interface

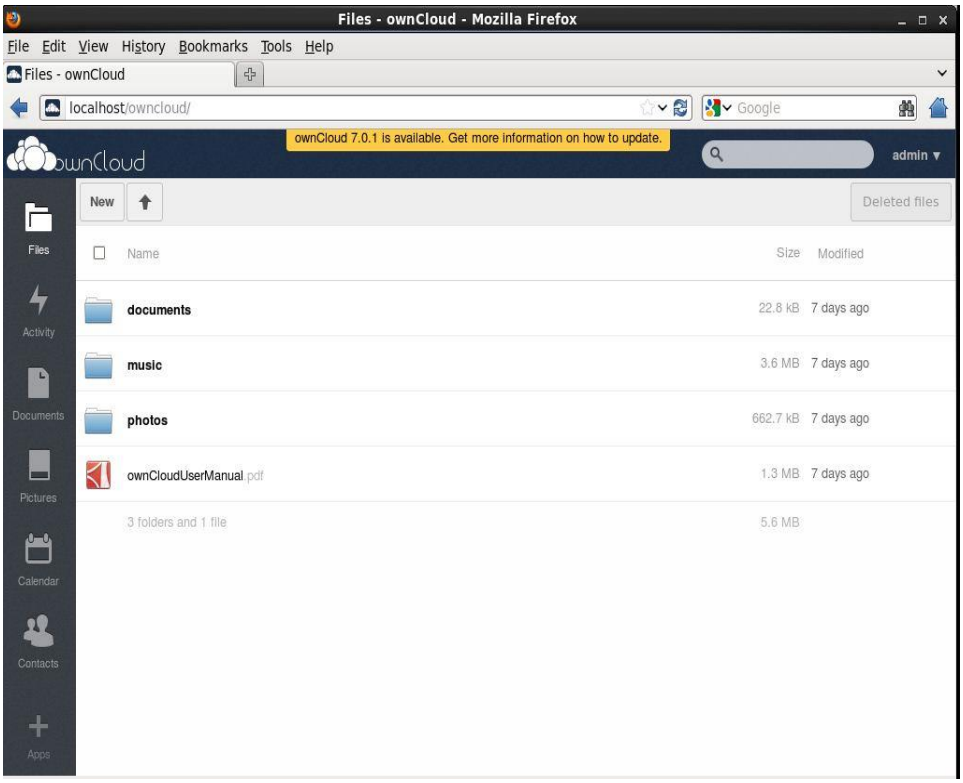
Administrator or user access ownCloud Software by insert his id and password. Dependent on the result of login administrator or user home page appears.



[Figure APPINDEX 20] OwnCloud login page

Administrator home page

Administrator uses this screen to deal with user data and information. Furthermore, he uploads or downloads files.

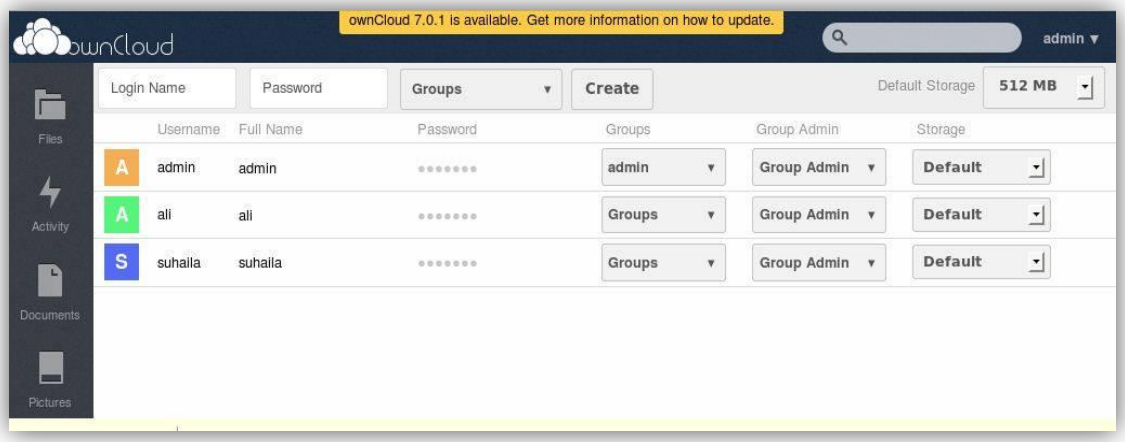


[Figure APPINDEX 21] Admin home page

Add users window

Administrator adds new user to system by insert user id in Login Name field and user password in Password filed then press Create button. Moreover, he can delete user or update his information.

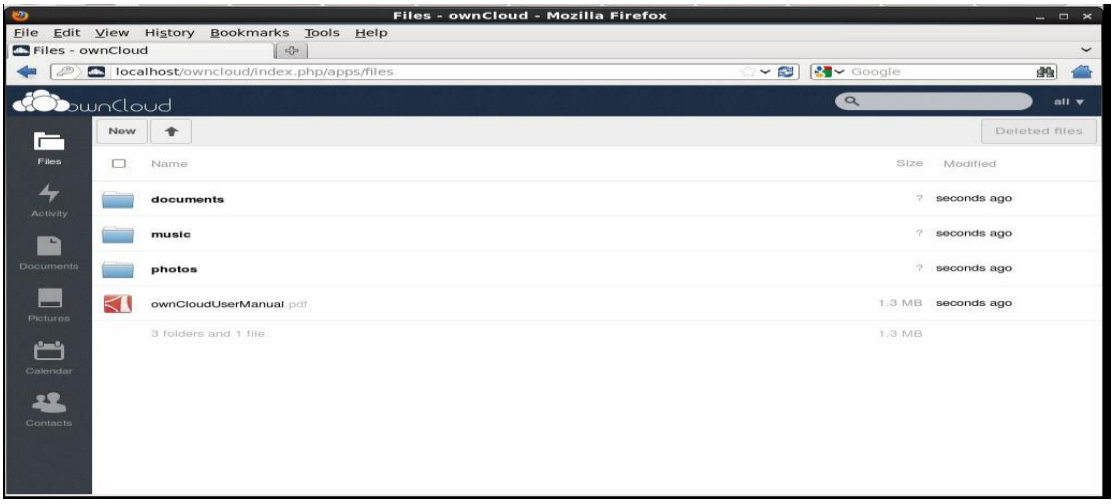
Another process can done in this window is changing default storage to all users or for specific user.



[Figure APPINDEX 22] Add user window

The user home page

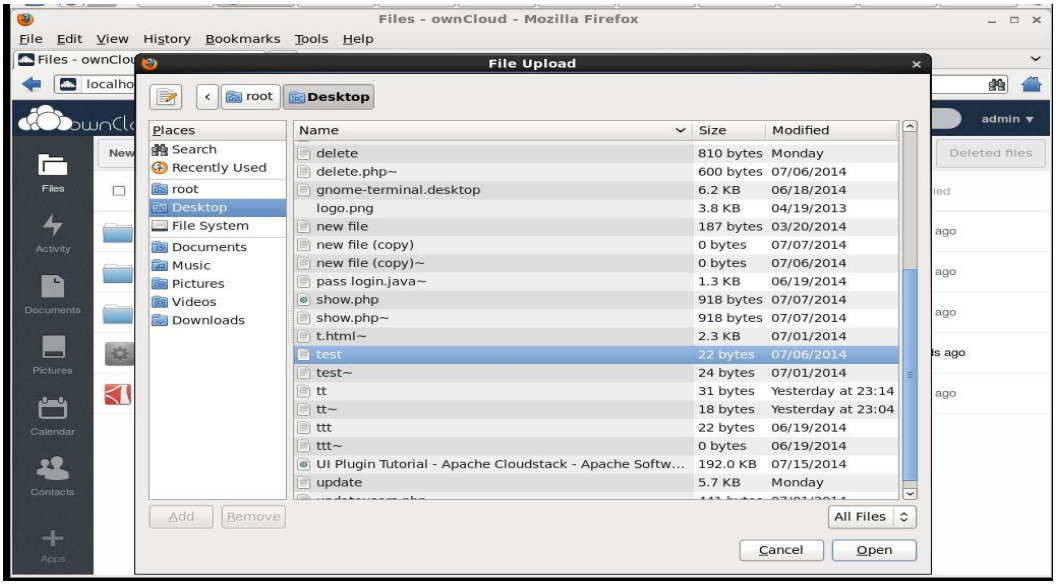
The useruses this screen to work with his information. Furthermore, he uploads or downloads files from any types.



[Figure APPINDEX 23] User home page

File uploading

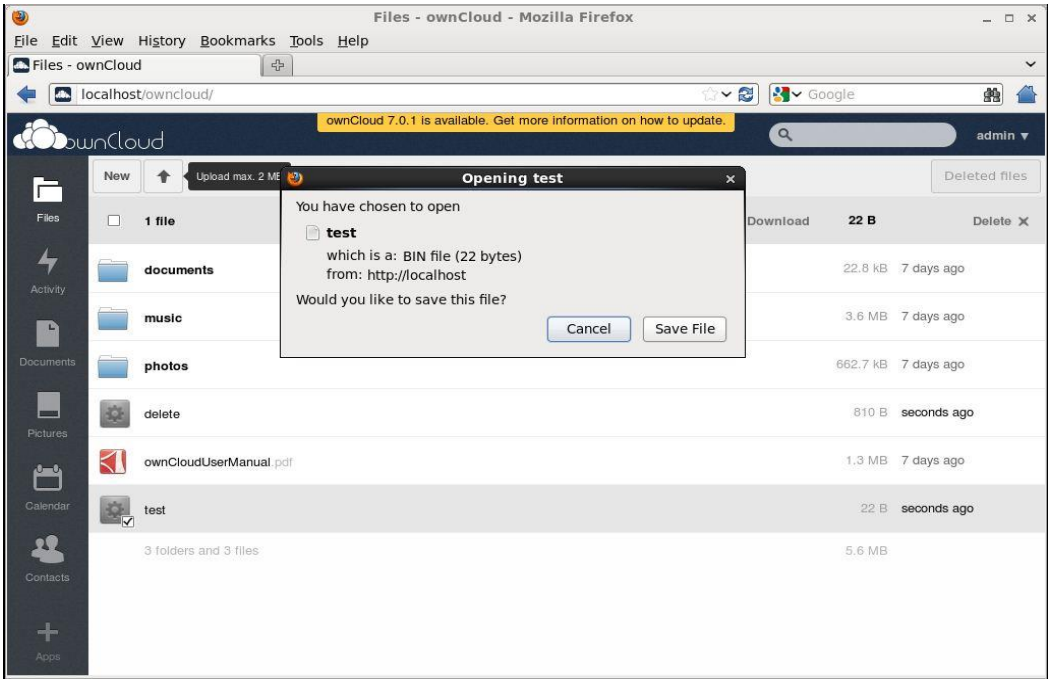
When the user click on upload button ,file upload wizard start, then he can select file to be upload into the cloud.



[Figure APPINDEX 24] Uploading file

File downloading

When the user clicks on file, download wizard will start, then he can save file to his computer device.



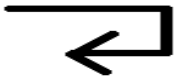
[Figure APPINDEX 25] Downloading file

APPENDIX III

Basic UML elements

This table includes description of UML elements.

[Table APPENDIX 1] Basic UML Elements Descriptions

Shape	Shape name	Shape Description
	Associate	Generaltype of relationshipbetweentheelements.
	Message	Refers to the flow of information control is transferred between the elements .Used in all schemes of interaction
	Return message	Show the response of message to the actor
	Self-Message	Reflect or suggest anew process known as the lifeline's operation
	Actor	Is a system’s user he could be a person, machine or even another system or part of system.
	Use Case	Describes and shows the interaction overtime with a single meaning for the end user of the system to perform a specific job.
	Boundary	Is a workbook that contains a collection of the use cases that are applied inside