CHAPTER ONE

Introduction

This chapter introduces the current research with the background of the problem described first. After that, the problem statement, objective, scope, and importance of the study are described respectively.

1.1 Background

As today, world can be considered as an IT world. Since, everything is revolving around the development of IT, its role and scope is increasing day by day. Every day, there are new innovations evolving in the field of IT to make people life easier and effective. Among them, cloud computing is one of the future generation of computing, characterized by three entities- software, hardware and net work, which is spreading its usefulness in every field

Scholars defined cloud computing in their own way according to their requirements and effectiveness of their business. In cloud computing the services are offered just-in-time over the internet in very cost-effective and flexible manner. While increasing the productivity, cloud computing mainly intends to reduce the implementation, maintenance cost and complexity. Cloud

computing enables the organization to scale up or down their services, whenever needed to optimize their resources.

According to National Institute of Standards and Technology 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. Every definition of the cloud is based on three important factors; characteristics, delivery models, and deployment methods.

WHO defines e-Health as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, surveillance, literature and health education, knowledge and research (e-Health Resolution, 2005). E-Health applies an advantage of e-Commerce to medical technology like telemedicine. E-Health supplies medical service like D2D (Doctor to Doctor), D2N (Doctor to Nurse), P2D (Patient to Doctor) and P2N (Patient to Nurse) to patients and clinic. If it fully applies these advantages of e-Commerce to health sector, patients and then, clinic receives an effective and convenient medical service like cost reduction, time and storage space.

Increased use of e-Health services requires a legal and ethical environment that ensures data privacy, security and confidentiality. While exchanging the medical data or patient health history, there must be the respect for human rights and

privacy within health personal or between countries (Report by the Secretariat, 2005).

In a medical setting, the cloud offers the potential of easy access to electronic medical records. Quick access to a person‘s medical history could speed up treatment, help to avoid complications, and even saves lives (Gottlieb, 2005). In addition, the cloud makes it easier for the patients to locate and keep track of their own medical history. However, on the other hand, patient also wants privacy and guarantees that their health information is secure.

1.1.1 **Cloud Computing**

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud was inspired by the symbol that's often used to represent the Internet in flowcharts and diagrams.[1]

1.1.2 Cloud Computing Model and Characteristics

Figure 2.1 shows visual model of cloud computing definition and this model is composed of five essential characteristics, three service models, and four deployment models.

Model of cloud computing

Visual Model Of NIST Working Definition Of Cloud Computing
http://www.csrc.nist.gov/groups/SNS/cloud-computing/index.html

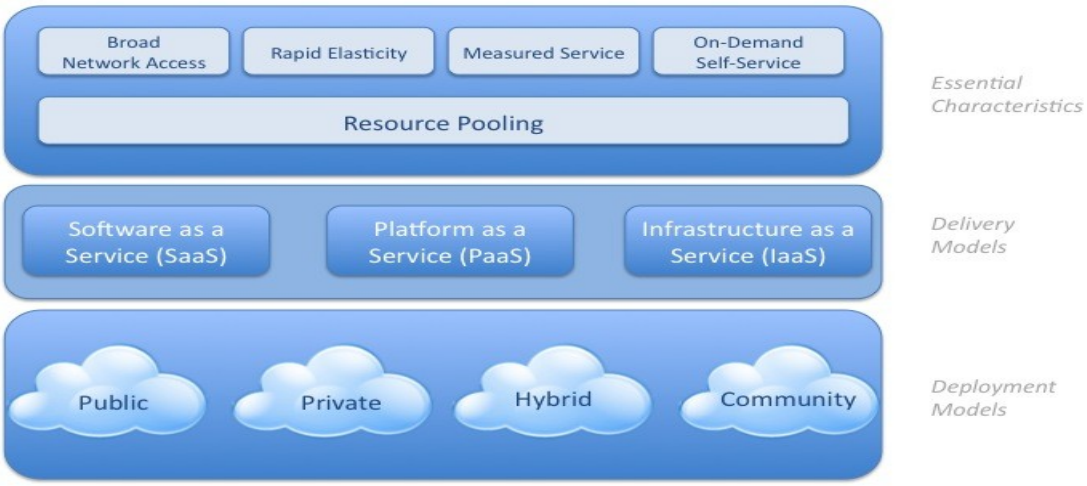


Figure 1.1 Model of cloud computing [2**]**

1.1.3 Essential Characteristics

There are five essential characteristics of cloud computing:

On demand self –service

Consumer can increase or decrease computing capabilities like servers, networks or storage as require without need of human interaction. It will help consumer to concentrate more on business to get good results.

Broad network access

Consumer can access the applications using heterogeneous (thin or thick) client platforms like mobile phones, laptops, PDAs. We will use standard mechanisms for accessing these applications.

Resource pooling

Dependant on consumer demand, different virtual and physical resources (networks, storage, processing, bandwidth and virtual machines) dynamically assign or reassigns to the specific application. These resources will assign to the applications based on multi-tenant model i.e. computer resources are pooled to serve multiple consumers. Consumer does not know the exact location where the data is stored but consumer may have a choice to choose the location of data center where he wants to store the data by specifying country or location of data center.

Rapid elasticity

Consumer has the ability to increase the resources whenever the demand is high and he is also able to reduce the resources like servers, virtual machines if the demand is less.

Measured service

Cloud systems can automatically measure the usage of resources by the type of service (storage, bandwidth, processing etc) provided and usage resources are monitored, controlled and reported by both consumer and cloud provider.

1.1.4 Delivery Models

Figure 2.1 shows the abstract layers of cloud service model. It maps the three service models with different security measures at various cloud operational levels.

Software as a Service (SaaS)

Software-as-a-Service sometimes refers as —on-demand software. This service provides software and associated data centrally, and easily access by the end users through thin client interface such as a web browser. Cloud provider rent software‘s to the end user as a service. Software delivers to the consumers in —one-to-many basis. Cloud provider maintains service level agreements to manage servers, operating systems, storage, individual applications as well as networks in infrastructure. Consumers do not require handling any upgrades or changes to

the software and do not need to manage any servers, networks, operating systems as well as individual applications. [3]

Platform as a Service (PaaS)

There is a capability that customer can deploy any type of application to the cloud infrastructure using any programming language and tools that are supported by the provider. The customer does not need to manage or control the cloud infrastructure including storage, networks, application, or operating systems but customer has control over the applications hosted configurations. Customer has a choice to use any type of operating systems and programming tools. PaaS uses multi-tenant architecture; therefore, multiple concurrent users can use the same development application.

Infrastructure as a Service (IaaS)

This service provides storage, provision processing, networks and other resources to the customer, where customer can deploys and run the arbitrary software like operating systems and applications. Customer does not manage or control the cloud infrastructure but the customer has control over operating systems, storage, applications and limited control on networking components. In IaaS, resources are distributed as a service. Customer does not need to buy servers; software, datacenter space and network equipment but he can use all these services for rent from cloud infrastructure as pay-as-you-use basis.

1.1.5 Deployment Models

Clouds are classified into four models based on their infrastructure and these are distinguished by their architecture and functionality.

Private Cloud

Private cloud is operated for specific organization and it may be managed by the organization or third party. SLA‘s are based on mutual understanding of cloud provider and the organization.

Public Cloud

Public cloud is owned by specific cloud service provider. This public cloud infrastructure is available for large organizations and public. SLA‘s are same to all the customers those who are using public cloud.

Community Cloud

This cloud is shared by a group of organizations and supports a specific community that has shared concerns. This may be managed by organizations or third party.

Hybrid Cloud

This cloud is a combination of private and public cloud. These clouds are bound together by standardized technology that enables data and application portability.

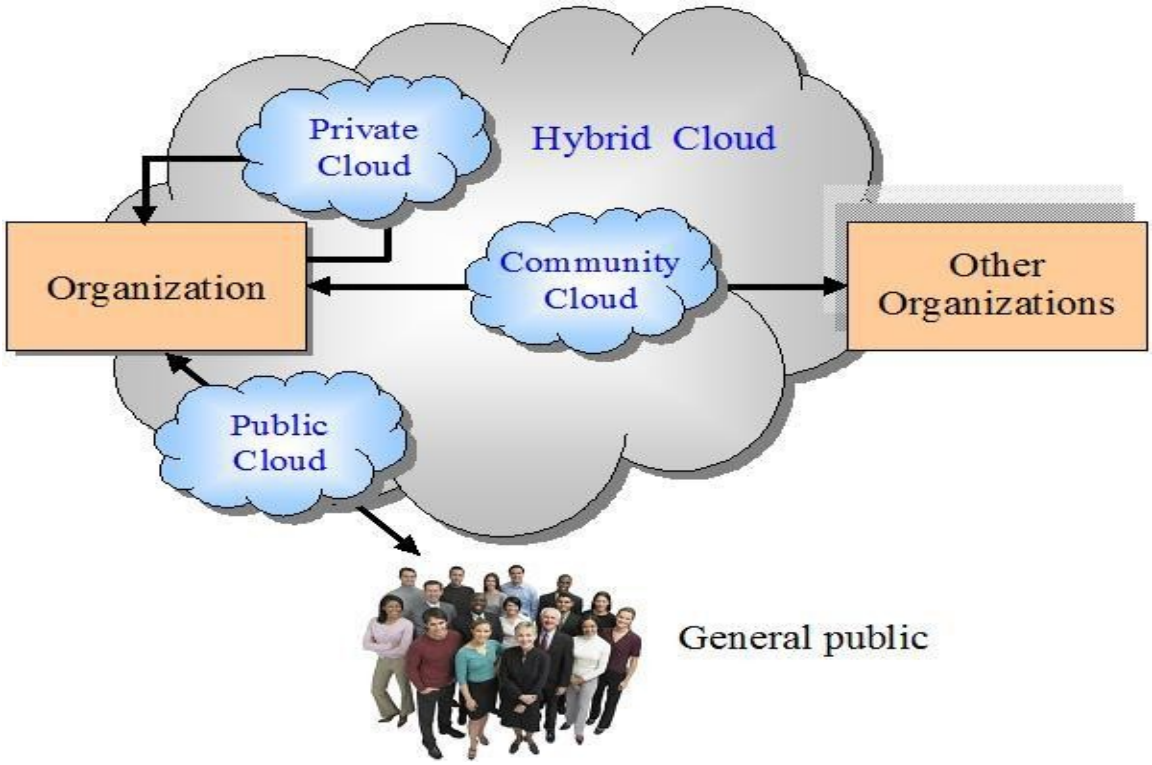


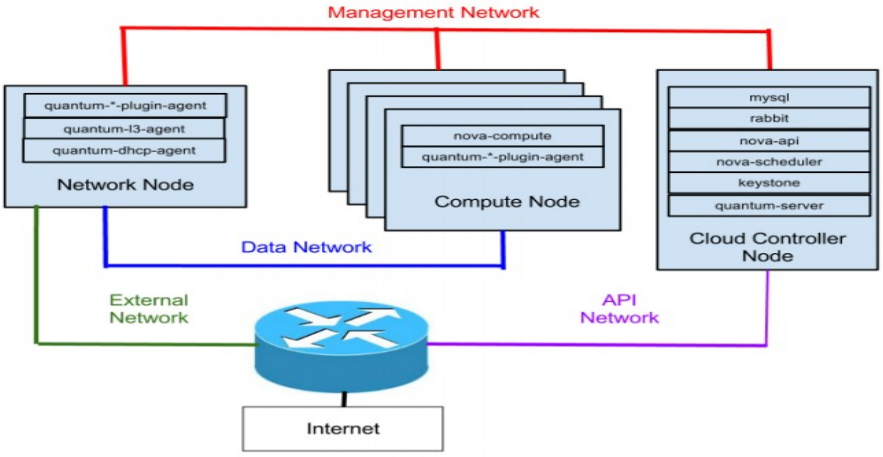
Figure 1.2 The four cloud computing deployment models [4]

1.1.6 Security Issues for Clouds

There are numerous security issues for cloud computing as it encompasses many technologies including networks, databases, operating systems, virtualization, resource scheduling, transaction management, load balancing, concurrency control and memory management. Therefore, security issues for many of these systems and technologies are applicable to cloud computing. For example, the network that interconnects the systems in a cloud has to be secure. Furthermore, virtualization paradigm in cloud computing results in several security concerns. For example, mapping the virtual machines to the physical machines has to be carried out securely. Data security involves encrypting the data as well as ensuring that appropriate policies are enforced for data sharing. In addition, resource allocation and memory management algorithms have to be secure. [5]

1.1.7 Structure of Open Stack

Open Stack is a collection of open source technology products delivering a scalable, secure, standards-based cloud



computing software solution. It is an open source infrastructure as a service (IaaS) initiative for creating and managing large groups of virtual private servers in a cloud computing environment. It has a modular architecture that currently has three components: compute, storage and image service.[6]

Figure 1.3 open stack architecture

1.1.8 Open Stack Components

As can be seen in Figure 2.4 Open Stack has a modular architecture that encompasses following components:

- Open Stack Compute (code-name Nova)
- Open Stack Object Storage (code-name Swift)
- Open Stack Image Service (code-name Glance)

- Open Stack Identity (code-name Keystone)
- Open Stack Dashboard (code-name Horizon)
- Open Stack Networking (code-name Quantum)
- Open Stack Block Storage (code-name Cinder)

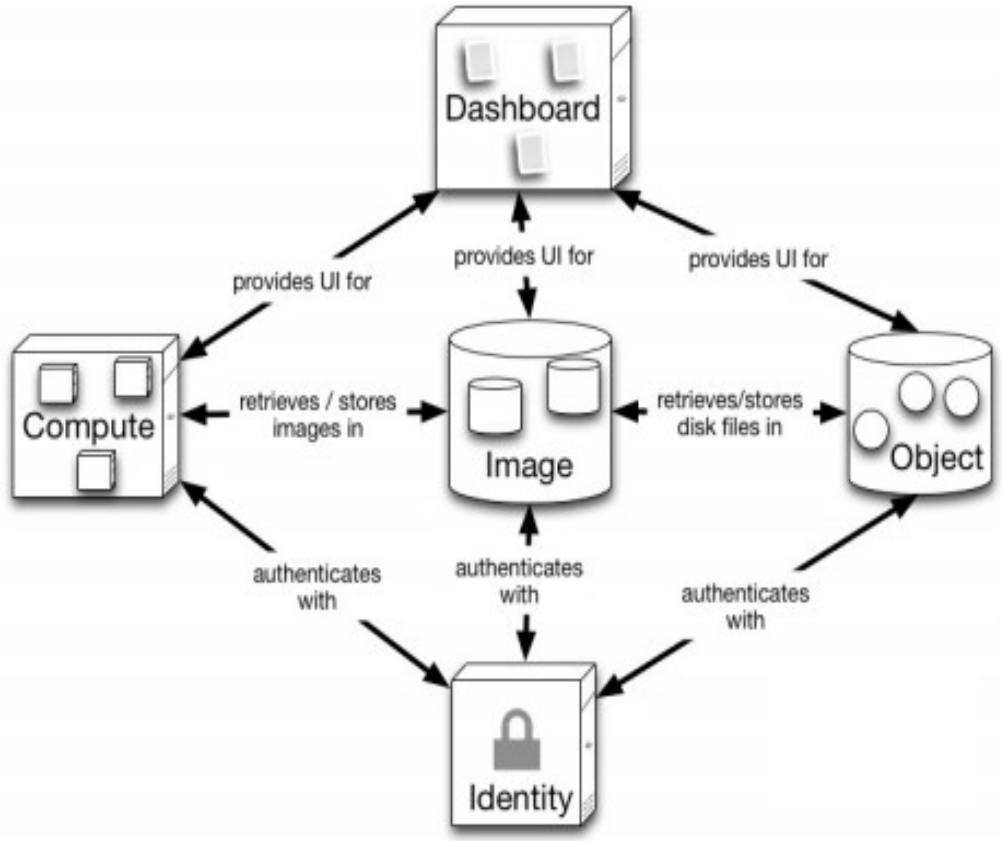


Figure 1.4 **Open Stack Components. [7]**

1.1.9 Health Cloud Computing Opportunities and Challenges

Health care, as with any other service operation, requires continuous and systematic innovation in order to remain cost effective, efficient, and timely, and to provide high-quality

services. Many experts predict that cloud computing can improve health care services, benefit health care research, and change the face of information technology (IT).

1.2 Problem Statement

Nowadays not just large organizations, but even small and medium size businesses are looking forward to adopt an economical computing resource for their business application, i.e. by introducing a new concept of cloud computing in their environment. Cloud computing improves organizations performance by utilizing minimum resources and management support, with a shared network, valuable resources.

Cloud computing raises many challenges and opportunities for the deployment of solutions to the technology that will work in practice. The model security is still questionable which impacts the cloud model adoption. The security problem becomes more complicated under the cloud model as new dimensions.

1.3 Objectives of thesis

This thesis aims to suggest guidelines for adoption of cloud computing in e-Health based on associates (health care personnel and cloud computing) concerns i.e. privacy concerns, security concerns, availability, efficiency and cost factor.

To meet the aim, there are certain objectives presented. They are:

- ✓ To find the current state of art of cloud computing and issues that involved in deployment of cloud computing.

- ✓ To identify and analyze the factors influencing cloud computing technology.
- ✓ To identify and analyze the associates (health care personnel and cloud computing) opinions on the factors involved in the adoption of cloud computing in e-Health.
- ✓ To propose new structure of cloud computing model and write new referral system that can meet the above objectives.
- ✓ To evaluate the propose model based on certain criteria.

1.4 Scope of the Thesis

This project focuses on the security risk assessment in traditional data center through deploying an open stack in cloud computing so as to:

1. Improves organizations performance by utilizing minimum resources and management support, with a shared network, valuable resources.
2. Build a new Model of cloud computing to trust by the State to provide safe health care services and can be easily reached.

1.5 Research Methodology

The model of healthcare cloud datacenter was emulated using an Open Stack with the following tools:

Table 1.1 Tools and Functions

NO	TOOLS	FUNCTIONS
1	Servers	Need to install main components of open stack like Identity

		Service, Compute Service, Image Service, Dashboard and Object Storage.
2	Desktop	Open stack need desktop with high capabilities in order to make best configuration of cloud.
3	Operating System	Ubuntu server 12.04 LTS distribution runs at servers and ubuntu desktop run at client.
4	Database management program	MYSQL. it is Object-Relational Database Management System available at many operating systems like Linux.
5	Open stack system	Is open source platform for creating and managing large groups of virtual private servers in cloud computing environment?
6	A Referral system	Can be defined as a process in which a health worker at a one level of the health system, having insufficient resources (drugs, equipment, skis) to manage a clinical condition.
7	Python Programming Language	It permits to work in high way and integrated with other os in effective way, so it can run in Java and .NET virtual machine.
8	PHP Programming Language	It is script language and interpreter that is freely available

		and used primarily on Linux web servers.
9	Virtual Box program	To operate three operating systems to synchronize we need three operator either natural or virtual installed in Ubuntu 12.04 (LTS).

1.6 Thesis Structure

Chapter 2 (Theoretical Background) gives literature review on cloud computing and e-Health. Also this chapter shows what the other doing in the field of cloud computing, the advantages and the disadvantages of using the health care model.

Chapter 3 (Research Methodology) consists of methods, which are used in this research, including design and implementation of open stack, write and applying referral system as service under cloud environment.

Chapter4: Model design and implementation of frame work using some components of open stack.

Chapter 5: Describe proposed of referral system which written from scratch and provide some screens explain the system in this thesis.

Chapter 6 (Conclusions) gives brief conclusions and recommendations for adopting cloud computing in e-Health.

CHAPTER TWO

Theoretical Background

2.1 Introduction

The previous chapter explains the cloud computing as general, this chapter describe or review what the others doing in this field.

2.2 Background

Cloud computing provide solution to the health sector by using specific technology , there are some activities and efforts are done this field by number of companies like Google ,Microsoft , …etc so this Thiess cover some of them

2.2.1 Cloud Computing in Health Sector

The healthcare industry is evolving while grappling with several socio-economic and technological challenges along with the need to drive down HIT costs. A solution to this problem could be sought by moving to the Cloud.

Managing massive clinical data or EHRs requires heavy capital expenditure for sourcing and maintaining the IT infrastructure needed to store, transfer, retrieve, modify or print data and reports. At a state or a national level this could mean the storage and management of thousands of terabytes of data. All of this can be done more efficiently and at minimum costs if the data is moved into the Cloud. The Cloud is a paradigm shift in HIT which enables stakeholders to focus more on their core competencies. In the case of the healthcare industry, it would involve the provisioning of healthcare products and services to patients by physicians, clinics, pharmacies, public health organizations, and payers.

2.2.2 The Current Role of Technology in Healthcare

The healthcare industry has been leveraging technological innovations for decades to provide superior quality services to patients. Medical technology-based devices and equipments such as Computed Tomography (CT) Scanners, Diagnostic Son graphic Scanners, Magnetic Resonance Imaging (MRI) Scanners, remote monitoring devices, health and wellness-check devices, etc. have helped in diagnosing health problems without the need for expensive and hazardous surgeries.

Information and Communication Technology (ICT) has performed a major role in digitizing and communicating patient information, leading to rapid patient diagnosis which further leads to faster time-to-treatment and superior overall health services .Stakeholders in the healthcare industry have benefited by ICT

applications in terms of efficiency and quality. Communicating digitized patient information is typically done through a system like ‘Telerate’. Volumes of patient data are transformed into information for decision-support through HIT applications and systems that are crucial for providing successful telecare services. Typically, healthcare providers make use of systems like Hospital Management Information System (HMIS), Picture Archiving and Communication Systems (PACS), Electronic Medical / Health Records (EMR /EHR) system or Personal Healthcare Records (PHR) system to facilitate clinical workflows in order to provide telecare services.

2.2.3 Cloud Computing Provider Efforts for Healthcare

2.2.3.1 Microsoft Health Vault

Microsoft developed a platform to store and maintains health and fitness information, called Health Vault. It is a cloud service that helps people collect, store, and share their personal health information. Health Vault’s data can come from providers, pharmacies, plans, government, employers, labs, equipment and devices, and from consumers themselves. Access to a record is through a Health Vault account, which may be authorized to access records for multiple individuals, so that a mother may manage records for each of her children or a son may have access to his father's record to help the father deal with medical issues. [8]

2.2.3.2 Google Health

Google provides a personal health information centralization services, known as Google Health. The service allows Google users to volunteer their health records, either manually or by logging into their accounts at partnered health services providers, into the Google Health system, thereby merging potentially separate health records into one centralized Google Health profile. Volunteered information can include health conditions, medications, allergies, and lab results. Once entered, Google Health uses the information to provide the user with a merged health record, information on conditions, and possible interactions between drugs, conditions, and allergies.

In general, Health Vault and Google Health serve as Cloud health information storages and operate separately. As consumers of different Cloud applications rely on Cloud Providers (CP) to supply all their computing needs (process, store and analyze huge sensor data and user generated data) on demand, they will require specific QoS to be maintained by their providers in order to meet their objectives and sustain their operations. To solve the problem of Cloud interoperation, Unified Cloud Interface (UCI) standardization has been proposed. [9]

2.3 Related Works:

2.3.1 Huawei Single Cloud

Cloud Design and Deployment on Intel® Xeon® Processor -based Platforms

Huawei Single CLOUD solution is designed for the cloud computing data centers of Cloud Service Providers and Enterprise Customers. Based on the Single CLOUD solution, Cloud Service

Providers construct network-based office environment which providing “pay as you go” server and storage services for enterprises, especially small and medium enterprises.

The Intel Cloud Builders Program offers a platform to show Huawei Single cloud solution optimized on Intel Xeon® processor-based platforms. Huawei provides the entire cloud computing solutions on hardware architecture, virtualization platform, and cloud software platforms.

The described can be implemented as a base-solution to build more lactic and complex environment of cloud computing.
Huawei Single cloud solution is a layered architecture. Through the virtualization, distributed storage, and cluster technologies, the devices on the physical layer and network layer are integrated to provide the storage, computing, and network services to upper-layer services. These services are managed uniformly, which assists carriers to build the data center operational capability.

Solution

The Single cloud solution applies the virtualization technology, which divides a physical server to multiple computers virtually. It provides a unified management on the physical servers and network devices. Based on the requirements, different virtual computers can be provided for employees. During the business trip or in the non-office area, employees can do business normally by accessing the virtual desktop cloud

Advantages:

1. Quick service deployment and Flexible Capacity Expansion.

2. Enhanced Cloud Security Scheme and reliability.
3. Unified and Centralized Resource Distribution.
4. Fast and Customized Rental Services.
5. Authority and Domain Based Management.

Disadvantages:

1. Need Support DMTF standard of cloud management.
2. High security specially in
   - Automatic patch service
   - VM anti-virus interface
   - Huawei-Symantec security equipment integrated
3. High availability
   - Distributed memory
   - Data center migration
4. Must be consider to

   -Scalability of the cloud solution could be impacted by(Network technology, storage architecture).

   - Hardware (it is important to note that the performance of virtual machines running on the cloud platform is heavily influenced by factors of processor architecture).

   - Security (is a key consideration in the selection and management of IaaS, A complete discussion of best practices for cloud security, from the perspective of both the Service Provider and the end-user organization). [10]

2.3.2 State of Indiana implements Cisco Unified Computing Systems (UCS) for streamlined workflow

Challenge:

The State of Indiana is the 16th most populous state in the United States and is located in the Midwestern and Great Lakes region. The Indiana Office of Technology's mission is to provide cost-effective, secure, consistent, and reliable enterprise technology to its partner agencies throughout the state. The office strives to bring the best and most appropriate technology solutions to bear on state technology applications as well as to improve and expand government services provided electronically. [11]

Although the department did not have serious issues with its previous environment, the department kept getting word that some better, more efficient options would help the department streamline efforts.

Solution:

Because no glaring problems occurred in Indiana's previous environment, moving forward to invest in new products required quite a bit of effort on the front end. "It was a tedious process to convince upper management to change the standard so we could invest in another platform.

The Management had looked into IBM, HP, Dell, and Cisco blades as vendor to make fully exploring all options.

The State of Indiana ended up choosing the Cisco Unified Computing System™ (UCS®) both for consistency in the data center but also because of the benefits that UCS could offer. Cisco® UCS allows Indiana to unify computing, networking, management, virtualization, and storage access into a single integrated architecture.

In addition to decreasing the number of devices that the IT department had to purchase, deploy, and maintain, the IT department was impressed with the service profiles, the anonymous nature of the blades, and the ability to have another level of virtualization.

Results:

Since the upgrade, Indiana's IT office has been completely modernized. The Cisco UCS solution allows the office to rapidly respond to surges in demand and has saved the way to getting more applications virtualized.

The implementation of UCS has allowed to be more agile, to build both physical and virtual servers to be identical, which has given a lot of flexibility and cut down significantly on implementation time.

In addition to a streamlined workflow within the department, the agencies that IT works with have experienced a greater ease-of-use because downtime and service issues have significantly decreased since the implementation.

Advantages:

1. The solution deal with existing environment.
2. Easy to choose better solution.
3. Share resource from vender that need few time to achieve their target.

Disadvantages:

1. Depend on Cisco UCS security level which provided by Cisco technology.

2. Until this solution concert to virtualization environment it need to deployment in physical space.

2.3.3 Cisco Enterprise Cloud Architecture

Savvies are a worldwide leader in providing Cloud, network, and managed hosting services. The company provides outsourced solutions for enterprise customers by combining cloud technology, an extensive global IP backbone, and over 50 data centers located in the United States, Europe, and Asia. More than 2500 customers, including many of the top 100 companies in the Fortune 500, use Savvies to reduce capital expense, improve service levels, and harness the latest advances in cloud computing. [12]

2.3.4 Intel Enterprise Cloud Architecture

Intel IT operates a massive, worldwide computing environment that supports about 78,000 Intel employees and includes approximately 100,000 servers. Though current environment has met Intel’s needs to date, the accelerating pace of business is driving a need to respond more quickly to changing business demands. At the same time, Intel IT is continually challenged to reduce cost. To meet business requirements mandating increased agility and efficiency, Intel has moved to a new enterprise architecture based on a cloud computing approach.

Intel has defined private cloud architecture to establish the overall direction of private cloud and to provide a foundation for

further development and innovation. The primary elements of this architecture include infrastructure as a service (IaaS), which provides dynamically scalable resources based on virtualized infrastructure; platform as a service (PaaS), which builds on IaaS and simplifies application development by adding standardized stacks of services used by a wide range of applications; and a self-service portal that enables business groups to request, manage, and track cloud resources. The cloud will also include some internally hosted SaaS multi-tenant applications. [13]

2.3.5 Discussion Cisco and Intel Enterprise Cloud Architecture

2.3.5.1 Advantages

- ✓ The Microsoft platform which it develops (health vault) help people to store maintains health and fitness information and enables different users to access to it.
- ✓ The Google health provides information centralization that allows volunteer to reach their health record remotely.
- ✓ Cloud computing act as an idle solution to face challenges in e-Health like quick medical diagnosis for fast treatment, collecting medical records and maintain privacy etc.

2.3.5.2 Disadvantages

- ✓ The Health Vault and Google Health serve as Cloud health information storages and operate separately. As consumers of different Cloud applications rely on Cloud Providers (CP) to supply all their computing needs on demand, they will require specific QoS to be maintained by their providers.
- ✓ The company provides out sourced solution for enterprise customer by combining cloud technology.
- ✓ There is no standard architecture to establish the overall direction of private cloud and to provide a foundation for further development and innovation.
- ✓ The problems of current e-health systems to protect of privacy-sensitive data and usability of e-health cloud systems, and their impact on healthcare and implications for privacy and the collection of medical records.
- ✓ Finally the health records must be saving in secured manner.

2.3.6 Discussion Huawei Single cloud and State of Indiana implements.

Every one of this related work deal with really environment which already has infrastructure done by the providers and applied their solution on it this is the advantages and not let both to make efforts to implement cloud from scratch furthermore the security ,accessibility , availability and network management in all layers of cloud are clear manner for them .

But this thesis dealing to IAAS, PAAS ,and SAAS layers form through virtual environment and also highlight the performance, security, accessibility and get out the advantages and disadvantages and describe how to evaluation them in the new virtual environment.

CHAPTER THREE

Research Methodology

3.1 Introduction

This chapter presents methodology to be adopted in continuing this research. Research procedures, operational framework, assumptions and limitations and research schedule are included.

In order to make a good appearance for this research, there is a deep need to pass through its procedure, which contains the main phases that the research passes to completion. The research questions are described along with the objectives that they answer. Generally the steps to be used in finishing this research are:

i. Studying the concepts of cloud computing.

ii. Surveying the types of cloud computing and different architectures.

iii. Surveying different health care services in cloud computing.

iv. Selecting two of the dominant cloud computing in health care services and studying characteristics.

v. Designing the framework based on the cloud computing in health care services.

3.2 Research Procedure

This procedure explains the main four phases that the research follows. The phases are: problem identification, framework design, validation and results dissemination which are shown in Figure 3.1. These phases are described in details.

Research Design and Procedure

Figure 3.1 **Research Design and Procedure**

System

3.2.1 Problem Identification

In this phase there is a deep searching on the problem of cloud computing and its importance. In addition the cloud computing discussed .It is found that in spite of the good functionality that the cloud computing gives, it has a serious problem needs to be addressed. The problem is that unfortunately, these systems provide large number of alerts which most of them of low importance of cloud computing. In addition, what makes it worse is that there are a lot of irrelevant features which increases the computational time and complexity.

This phase also addresses studying and analyzing the past of cloud computing reducing cost (including an open stack) and identifying their strengths and weaknesses.

3.2.2 Framework Design

Identifying the problem and surveying, the researchers proposed solutions. Now it is time to design a new framework for solving the cloud computing in health care problem. So this phase compares between dominant of the cloud computing in health care and designs the proposed framework based on the results of comparison forming development architecture.

3.2.3 Validation and Justification

This phase justifies the proposed framework. This can be done by listing all its advantages and disadvantages.

3.2.4 Results Dissemination

This phase elaborates the expected results of the whole research. It binds the previous phases with each other, so to have a mature thesis.

3.3 Operational Framework

This section summarizes the research key questions along with the objectives and deliverables. This is shown in Table 3.1

Table 3.1: Operational Framework of the Research

No	Research Question	Objective	Activity(s)	Deliverable(s)
1	What is the purpose of researching cloud computing in health care areas?	To delve deep into concepts corresponding to reducing cost, secured techniques and share pool resources.	Literature review	˚ A fully documented thesis that addresses the aspects, researchers proposed different solutions in the past however this research paper proposes a novel solution
2	Why choose the cloud computing in health care?	To spotlight the importance of the secured in	˚ Literature review ˚ Design	˚ cloud computing framework

		health care services.		
3	Why use the most prominent of cloud computing in health care?	To compare between prominent architectures	ð Literature review ð Design	ð Feature selection framework ð Result of the thesis

3.4 Research Limitations:

Due to the time constraints there was neither implementation nor testing for the framework to compare it with other cloud computing. This research addresses only the cost reducing and security techniques (especially in open stack). It does not consider other processes such as classification. In addition it does not address the hall security techniques, nor alert correlation techniques.

3.5 Summary

This chapter presented the research procedures that compose the research life cycle, operational framework in which the key research questions and limitations are addressed.

CHAPTER FOUR

Research Discussion and Proposed open stack Framework Design

4.1 Introduction

This chapter describes the most dominant of cloud computing in health care services along with their open stack features and benefits and main component of it in details, so also describe the environment of open stack framework that prepared to install referral system on it .furthermore discus the Proposed Framework Justification and frame work structure. Then describe the open stack implementation and finally discus the advantages and disadvantages.

4.2 Definition

Open Stack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface.

4.3 Table for Open Stack Features & Benefits

Leverages commodity hardware	No lock-in, lower price/GB.
HDD/node failure agnostic	Self-healing, reliable, data redundancy protects from failures.
Unlimited storage	Large and flat namespace, highly scalable read/write access, able to serve content directly from storage system.
Multi-dimensional scalability	Scale-out architecture: Scale vertically and horizontally-distributed storage. Backs up and archives large amounts of data with linear performance.
Account/container/object structure	No nesting, not a traditional file system: Optimized for scale, it scales to multiple pita bytes and billions of objects.
Built-in replication 3× + data redundancy (compared with 2× on RAID)	A configurable number of accounts, containers and object copies for high availability.
Easily add capacity (unlike RAID resize)	Elastic data scaling with ease

No central database	Higher performance, no bottlenecks
RAID not required	Handle many small, random reads and writes efficiently
Built-in management utilities	Account management: Create, add, verify, and delete users; Container management: Upload, download, and verify; Monitoring: Capacity, host, network, log trawling, and cluster health.
Drive auditing	Detect drive failures preempting data corruption
Expiring objects	Users can set an expiration time or a TTL on an object to control access
Direct object access	Enable direct browser access to content, such as for a control panel
Real-time visibility into client requests	Know what users are requesting.
Supports S3 API	Utilize tools that were designed for the popular S3 API.
Restrict containers per account	Limit access to control usage by user.
Support for NetApp , Nexenta, Solid Fire	Unified support for block volumes using a variety of storage systems.

Snapshot and backup API for block volumes	Data protection and recovery for VM data.
Standalone volume API available	Separate endpoint and API for integration with other computer systems.
Integration with Compute	Fully integrated with Compute for attaching block volumes and reporting on usage.

In open stack each of the following services has different resource requirements. And requires design since individual characteristics and service mass can impact the hardware selection process Hardware designs are generated for each type of the following resource pools:

- Compute
- Network
- Storage

Hardware decisions are also made in relation to network architecture and facilities planning into the overall architecture of an Open Stack cloud.

4.4 Designing compute resources

To designing compute resource pools, a number of factors can consider like processors, memory, and storage within each hypervisor are just one element of designing compute resources to be addressed on-demand.

It is also important to consider the compute requirements of resource nodes within the cloud. Resource nodes refer to non-hypervisor nodes providing the following in the cloud:

- Controller
- Object storage
- Block storage
- Networking services

4.5 Designing network resources

Open Stack clouds have multiple network segments, each of which provides access to resources within the cloud to both operators and tenants. The network services themselves also require network communication paths which should be separated from the other networks.

4.6 Legacy networking (nova-network)

The legacy networking (nova-network) service is primarily a layer-2 networking service that functions in two modes that differ in their use of VLANs. When using legacy networking in a flat network mode, all network hardware nodes and devices throughout the cloud are connected to a single layer-2 network segment that provides access to application data.

When the network devices in the cloud support segmentation using VLANs, legacy networking can operate in the second mode. In this design model, each tenant within the cloud is assigned a network subnet which is mapped to a VLAN on the physical network.

4.7 Open Stack networking (neutron)

Open Stack Networking (neutron) is a first class networking service that gives full control over creation of virtual network resources to tenants. This is often accomplished in the form of tunneling protocols which will establish encapsulated communication paths over existing network infrastructure in order to segment tenant traffic.

4.8 Designing storage resources

Open Stack has two independent storage services to consider, each with its own specific design requirements and goals. In addition to services which provide storage as their primary function, there are additional design considerations with

regard to compute and controller nodes which will affect the overall cloud architecture.

4.9 Designing Open Stack Object Storage

When designing hardware resources for Open Stack Object Storage, the primary goal is to maximize the amount of storage in each resource node while also ensuring that the cost per terabyte is kept to a minimum.

4.10 Designing Open Stack Block Storage

When designing Open Stack Block Storage resource nodes, it is helpful to understand the workloads and requirements that will drive the use of block storage in the cloud. To designing block storage pools so that tenants can choose appropriate storage solutions for their applications.

4.11 Software selection

The software selection process plays a large role in the architecture of a general purpose of cloud. The following have a large impact on the design of the cloud:

- Choice of operating system
- Selection of Open Stack software components
- Choice of hypervisor
- Selection of supplemental software

In this thesis the operating system selection is: ubuntu 12.o4 LTS because it has some flexibility in hypervisor; KVM, Xen, and supported virtualization methods available under Open Stack

Compute (nova) on these Linux distributions. And the Open Stack cloud platform determines the best choice of an OS-hypervisor which includes:

- User requirements
- Support
- Interoperability
- Hypervisor [kvm(and QEMU)]

4.12 Open Stack components

An Open Stack cloud design should incorporate the core Open Stack services to provide a wide range of services to end-users. The core services in Open Stack cloud are:

- Open Stack Compute (nova)
- Open Stack Networking (neutron)
- Open Stack Image service (glance)
- Open Stack Identity (keystone)
- Open Stack dashboard (horizon)

4.13 Supplemental software

An Open Stack deployment consists of more than just Open Stack-specific components. A deployment involves services that provide supporting functionality, including databases and message queues, and may also involve software to provide high availability of the Open Stack environment. Design around the underlying message queue might affect the required number of controller services, as well as the technology to provide highly resilient database functionality. Deployments use hardware load

balancers to provide highly available API access and SSL termination, software solutions.

4.14 Performance

Performance of an Open Stack deployment is dependent on a number of factors related to the infrastructure and controller services. The user requirements can be split into general network performance, performance of compute resources, and performance of storage systems.

4.15 Controller infrastructure

The Controller infrastructure nodes provide management services to the end-user as well as providing services internally for the operating of the cloud. The Controllers run message queuing services that carry system messages between each service. Performance issues related to the message bus would lead to delays in sending that message to where it needs to go.

4.16 Network performance

Open Stack cloud requirements of the network help determine performance capabilities. Small deployments may employ 1 Gigabit Ethernet (GbE) networking, whereas larger installations serving multiple departments would be better architected with 10 GbE networking. The web application instances that run on a public network presented through Open Stack Networking has 1 GbE capability; whereas the back-end

database uses an Open Stack Networking network that has 10 GbE capabilities to replicate its data.

4.17 Compute host

The choice of hardware specifications used in compute nodes including CPU, memory and disk type directly affects the performance of the instances.

4.18 Storage performance

Open Stack Block Storage, hardware and architecture choice is important .Because block Storage can use enterprise back-end systems. And a user’s access to the Object Storage is through the proxy services.

4.19 Security

A security domain comprises users, applications, servers or networks that share common trust requirements and expectations within a system. They have the same authentication and authorization requirements and users. The security domains are:

- Public
- Guest
- Management
- Data

These security domains can be mapped to an Open Stack deployment individually, or combined. Some deployment topologies combine both guest and data domains onto one physical network, whereas in other cases these networks are

physically separated. In each case, the cloud operator should be aware of the appropriate security concerns. The domains and their trust requirements depend upon whether the cloud instance is public, private, or hybrid.

4.20 Open Stack Model Design and Implementation

This thesis comprises the following: cloud environment which is built using Open Stack, two configured servers (1, 2), and one client. Since Open Stack components follow a shared-nothing policy, each component or any group of components can be installed on any server. Server1 is called cloud controller install 64 bit version of Ubuntu server 12.04 and configure on it all nova-services including nova-compute, nova-api, nova-volume, and nova-network, Glance, Swift, Keystone and Horizon. It contains two network interface cards (NICs). And server 2 is called nova controller. This server runs only nova-compute service and install 64 bit version of Ubuntu server 12.04. After that 64-bit version of Ubuntu 12.04 Desktop is installed which is not a required component in our sample setup, it is used for bundling images, as a client to the web interface and to run Open Stack commands to manage the infrastructure. Having this client ensures that you do not need to meddle with the servers for tasks such as bundling. Also, bundling of desktop systems including Windows will require a GUI and it is better to have a dedicated machine for this purpose. Figure 4.1 below shows this idea. Installation and configuration for each devices and system in this thesis shown

later. Methods of installation and configuration of Referral System which is representing the main service in this thesis introduced in the cloud computing technology.

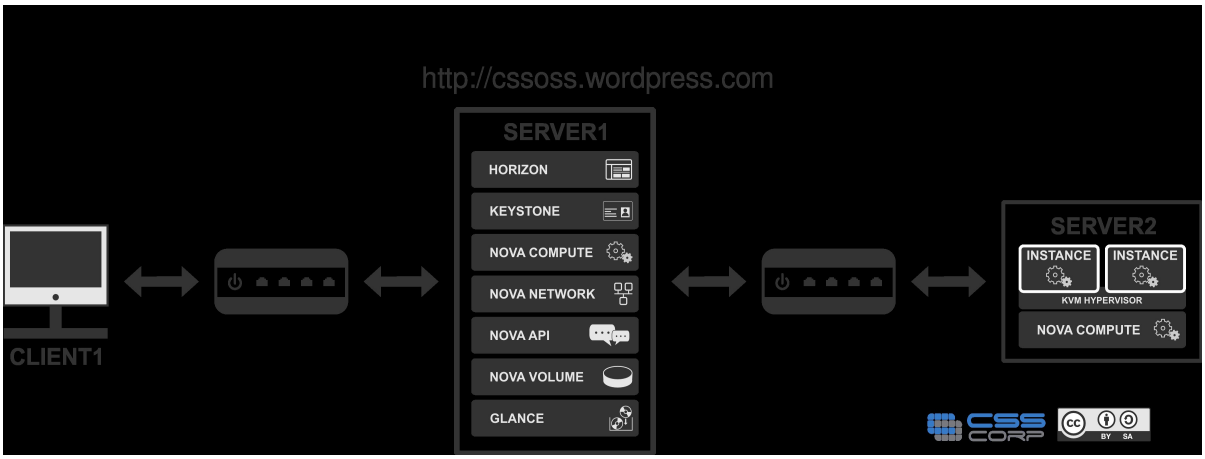


Figure 4.1 **Model design and implementation.[14]**

In this thesis the cloud computing paradigm optimizes in costs of physical resources (servers, CPUs, memories,) by the virtualization techniques that lets a single PC or server simultaneously run multiple operating systems or multiple sessions of a single OS. This lets users put numerous applications and functions on a PC or server, instead of having to run them on separate machines as in the past. Applications/services and basic functions provided in a Cloud are based on the Virtual resources which are abstracted from Physical Resources.

- Virtual physical resources, such as V-CPUs, V-Storages, VNetworks etc.
- V-Networks can be further divided into V-Routers and VSwitches.
- V-Firewalls, VPNs, V-Interfaces, V-Links based on physical Router/Switch equipment

Computational resources are managed in terms of Virtual Machines (VMs) and/or Virtual Clusters (VCs). Despite of the virtualization of resources, the cloud computing threats do not distinguish between real and virtual components. To simplifies the mechanisms of operation in cloud architecture. This thesis uses the names of components independent of their types (virtual/physical). A sample cloud computing system content includes:

- A browser.
- A proxy server.
- A router/Firewall.
- A load balancer.
- A web server.
- An application server.
- A database server.
- A backup server, and
- A storage server

4.21 proposed frame work structure

Because there are no enough resources available to deploy the real environment of open stack cloud, so in this thesis choose the virtual box to deploy on it, and there are some change done in the component by rewrite scripts to equivalent the need of this thesis.

To show installation and configuration of open stack under Linux (ubuntu 12.04 LTS) go to appendix (D)

4.22 Proposed Framework Justification

From a theoretical point of view, the proposed framework has many advantages:

i. Using open stack theory benefits to start the process without prior knowledge where most other cloud computing in health care requires supplementary knowledge.

ii. Using components of open stack based on cloud computing yields high security in cloud computing.

iii. While virtual environment does not evaluate the features, security In accurate manner but open stack evaluates and calculating the security in each level specially when deployed referral system as service on it.

However, the proposed framework has some **disadvantages:**

i. cloud computing in health care deals only with virtual environment.

ii. Security measured may not scale well when testing the security level in this environment.

These problems can be solved by applying this thesis in real environment. It can be considered in the future work.

4.23 The Results

There is no standard architecture to deploy open stack cloud but according to the resources available and their need should choose the component of open stack and it has ability to rewrite the scripts of open stack to achieve requirements.

CHAPTER FIVE

Referral System proposed In this thesis

5.1 Introduction

Referral system coordinates medical between the government and private hospitals in the region and the main objective of the system is to achieve the greatest of ease and speed of referral cases of disease to the hospital appropriate for

sponsoring special cases of life-saving that need referral from hospitals peripheral to central hospitals of reference, where the analysis of treatment referral by system during the three data first of specialization required of the situation, and then chooses the proper hospital, as well as considering the type of hospital , where he was the division of the hospitals in the system to several levels of medical by human potential and capacity and clinical equipment required, as the system works now with samples randomly for some hospitals to illustrate the idea and only can applied to the ground.

There are four cases satisfactory are coordinated from hospitals peripheral to central hospitals of reference within and outside the city of Khartoum, the first life-saving, or a member of the Members that may be exposed to the risk of an injury is the second ambulatory include accidents or cases of disease emergency third routine cases, which include patients with chronic diseases or health problems fourth Red Crescent, which include coordination of all patients across the Red Crescent to hospitals in the region through the mechanism of coordination between e-government hospitals.

An effective referral system ensures a close relationship between all levels of the health system and helps to ensure people receive the best possible care closest to home. It also assists in making cost-effective use of hospitals and primary health care services. Support to health centers and outreach services by experienced staff from the hospital or district health

office helps build capacity and enhance access to better quality care. In many cloud computing, a high proportion of clients seen at the outpatient clinics at secondary facilities could be appropriately looked after at primary health care centers at lower overall cost to the client and the health system.

Therefore the Referral system in this thesis deployed under open stack environment and deal with one module as a service , though it use some utilities like PHP, MYSQL, and ampServer2.0i.

5.2 Definition

Referral system forward or re-forward the patient from low level to higher level in order to find good and quality services from specialist hospital and specific consultants.

5.3 Referral System Historical Background

It is noted that the government or private hospital there are not a quick way to refer patients who require their cases move from the peripheral hospital to a reference hospital to find best services in order to save their lives, but that the peripheral hospitals where good medical services with full care and had no independent resources are not available, which summoned patient that make effort and money spent to reach the center for high-quality medical services and you may need for surgical intervention or conduct laboratory tests or conduct advanced research and most hospitals is not canceled, including full medical coordination to refer patients.

5.4 Reason for referral

1. Order diagnosis.
2. Confirm the diagnosis.
3. Specialized medical treatment.
4. Surgical intervention.
5. Conduct laboratory tests or conduct advanced research.

5.5 Goals of Referral System

1. To provide timely referral of patient in case of emergency
2. To enhance information sharing among health facilities and volunteers to provide continuous of life.
3. To provide new system to achieve the referral case to appropriate hospital in time**.**

5.6 Specific Goals

- ✓ Request for conversion of patients from one hospital to another.
- ✓ Approve the transfer of patients from one hospital to another electronically.
- ✓ Attach a medical report of the patient as an attachment to a letter; to facilitate the preparation procedures before the arrival of the patient to emergency situations, and for the information of the physician when needed.
- ✓ Reduce the administrative burden and follow up the conversion process automatically.
- ✓ Quickly convert patients from one hospital to another.
- ✓ Follow up and find out the reasons for rejection of the conversion process by the hospital transferee.
- ✓ Address the obstacles that prevent the conversion process, if any.

5.7 Current situation

The patients who need their cases to take care of special cases to save the life that need referral from peripheral hospital to a reference by specialization required to save their lives after the will of God Almighty. This referral may do by people with the patient after their coordination with any of the hospitals available

via telephone or by a specific person and is all efforts assignment effort where there is no personal electronic referral system now in Sudan.

5.8 Standard Referral Procedures

Referral system determines the referral procedures of all hospitals to the top level by specialization, distance and level the hospital to be Referral Mechanism, equipment and other necessary condition to receive the allocated factors.

Depending on the patient's condition system determines the assignment, In cases of life-saving or a member of the Members are converted case directly from the emergency departments sent to the emergency departments at hospitals receiving, through quick action system and then the system will determine the reference appropriate hospital to receive the case, and the same thing for the cases of ambulatory, where the system immediately after the data entry for the case of the nomination of hospitals that can provide treatment services to the patient depending on the specialization required and the quality of the bed, such as intensive care bed or bed medical departments, as well as the temporal distance that the patient may it take to get to the hospital, and be a trade-off factors between candidates hospitals to receive and clear cases exactly in front of the hospital management sender to choose the most appropriate in the light of their knowledge of the status of the patient.

The routine cases that need to refer from peripheral hospitals to referral hospitals, through a clear mechanism for the coordination of both the treatment of the patient by foreign or

hypnologic clinics at the hospital and required surgical interventions and tests if there is a need for it, as well as medical consultations

5.9 Coordinate between Hospitals

The system offers more possibilities for coordination between the reference hospitals and terminal identification of the patient's condition, which is forwarded whether traffic or fires or other accidents, as well as to identify the reasons for referral from one hospital to another and whether the referral because there is no vacant beds or lack of medical specialization required, as well as to identify the purpose of the referral Is limited to provide medical advice or treatment services, and testing and hypnosis.

The system also includes knowledge of the means of transfer of patients, whether by ambulance or medical evacuation teams or private cars to people with patients in routine cases, in addition to the initial diagnosis emergency and ambulatory situations and the patient's condition

5.10 proposed Referral System

Referral system based medical coordination between government and private hospitals in the region and the main objective of the system is to achieve the greatest of ease and speed in the referral of pathological cases to the appropriate hospital special cases life-saving that need referral of the parties to the hospital to a reference hospital, where the transaction is an analysis of the referral of the sponsorship by the system during the three data first of specialization required for the event, and then choose the nearest hospital, as well as studying the hospital

type, where the division of the hospitals in this system to several medical levels by human potential and clinical capacity required fittings, where the system is designed to provide referral services for patients according to the classification adopted for each Hospital and what consultations available.

5.10.1 Operation mechanism

Fill in a special form to apply for the service contain sufficient information, including identifying information of the patient, the hospital and assigned him to the assignee and the type of service required for the first diagnosis etc. (attached form)

5.10.2 Benefits

The application functions and work the system in accordance with the powers of the users, and the mechanism of the hospital best suited to determine to receive the case based on the specialization and the distance and classification of hospitals, and is characterized by high speed of communication and the disposal of securities necessary to keep them and the space, with the possibility of determining the physician to the patient and communicate with him by the hospital future system and is considered a reference Per conversion processes which helps in future studies and guidance.

5.10.3 Technical specifications

- ✓ Be sent to treatment from the hospital sent to the electronic operating room in the hospital future in accordance with the terms of the conversion system

and then the person in charge at the hospital future print the special situation of the medical reports and then presented to a physician for review and address the medical coordinator to accept or apologize for the reception case, the system provides all types of records recognized events. The system provides the possibility of classification of cases according to their nature or its medical field.

- ✓ The system also monitors and follow all the procedures done on cases from the moment of arrival until the end of treatment and are archived, and documented within the databases are queried about the events that has them at a later time.
- ✓ The system provides electronic forms for some situations and events that are defined in the system. It can include images and electronic attachments when you create a transaction in order to clarify who receives treatment.
- ✓ Mechanism transactions are numbered and legible manner permitted to deal with the treatment and movements so as the cases transactions to hospitals by filling customized electronic forms.
- ✓ The system provides detailed statements and a total reports, and statistical and analytical reports such transactions according to the log, and the transaction is ended.

- ✓ The system provides an electronic mechanism easy to get to the nearest hospital capable of patient reception and this lead to the patient's rescue in hazardous situations that lead to death, and can through the system referral information for treatment, and automatically and in a way automated within the method of referral ID, advance through the automatic referral in the system.
- ✓ The system provides the ability to make users through the means for process and password its own name.

5.10.4 Referral System components

System consists of four basic parts each part has subdivided such as:

A) Ambulance sites include (ambulance name, position, state, locality, telephone)

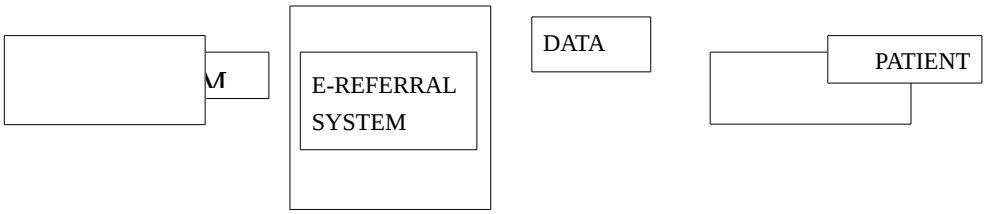
B) **Service request** include

1. Emergency unit like (ccu , hdc , icu)
2. Specialization clinic like (ENT ,ophthalmology emergency)
3. Hospital referring like (CTscan, pharmacy ,oncology)
4. Referring services like (word bed, isolation room, nursery)
5. Supported services like (x-ray, blood bank, CTscan)

C**) Follow up** include (request service, destination, date, request form, status)

D) **Service approval** include) request service, referral form, date, request form, status)

5.10.5 Context Diagram for Referral System:


M
E-REFERRAL
SYSTEM
DATA
PATIENT

5.10.6 Data Flow Diagram for Referral System

5.10.7 Data base Dictionary for Referral System

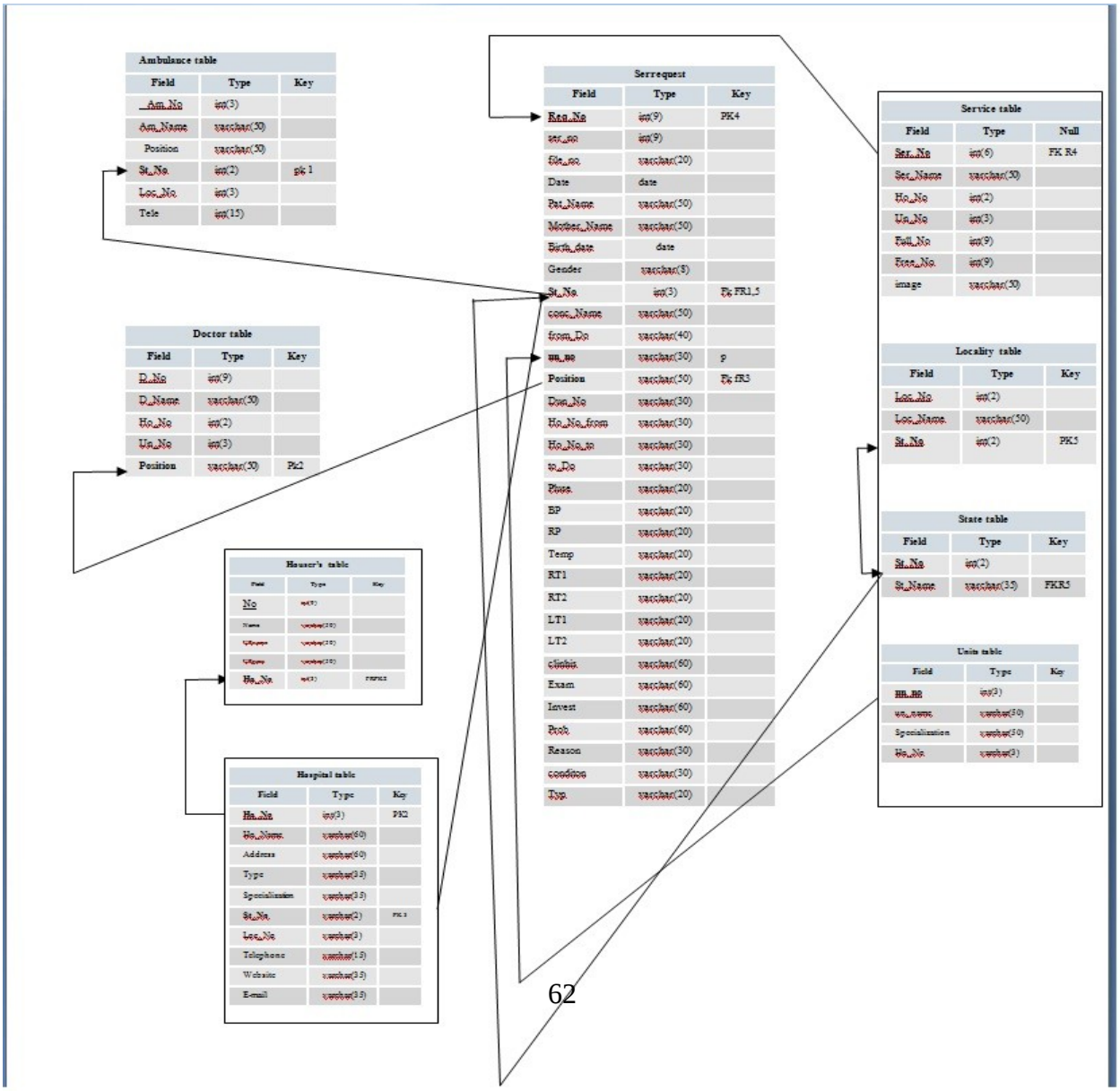
P/F	Field name	Caption	Data type	File size	notes
	Am_No	Ambulance number	integer	3	

	Am_Name	Ambulance name	varchar	50	
p	Position	Ambulance position	varchar	50	
p	St_No	State number	int	2	
	Loc_No	Locality number	int	3	
	Tele	Telephone number	int	15	
	D_No	Doctor number	int	9	
	D_Name	Doctor name	varchar	50	
p	Ho_No	Hospital number	int	2	
	Un_No	Unit number	Int	3	
	Position	Unit position	Varchar	50	
	Ho_Name	Hospital name	Varchar	60	
	Address	Hospital address	varchar	60	
	Type	Hospital type	varchar	35	
	Specialization	Specialization name	varchar	35	
	Website	Hospital Website	varchar	35	
	E-mail	Hospital E-mail	varchar	35	
	No	Houser number	int	9	
	Name	Houser name	varchar	50	
	USname	Houser username	varchar	50	
	USpass	Houser password	varchar	50	
	Loc_Name	Locality name	varchar	50	
p	Req_No	Request number	int	9	
f	ser_no	Service number	int	9	

	file_no	File number	varchar	20	
	Date	Date of request	date		
	Pat_Name	Patient name	varchar	50	
	Mother_Name	Mother of patient name	varchar	50	
	Birth_date	Birth of patient	date		
	Gender	Gender of patient	varchar	8	
	conc_Name	Consultant name	varchar	50	
	from_Do	Referral from doctor	varchar	40	
f	un_no	Unit number	varchar	30	
	Position	Unit position	varchar	50	
	Ho_No_from	Peripheral hospital	varchar	30	
	Ho_No_to	Reference hospital	varchar	30	
	to_Do	To doctor	varchar	30	
	Pluse	Pluse of patient	varchar	20	
	BP	blood pressure	varchar	20	
	RP	Retinitis pigmentosa	varchar	20	
	Temp	Temperature	varchar	20	
	RT1	Respiratory therapist	varchar	20	
	RT2	Radiation therapy	varchar	20	
	LT1	Primary Laboratory test.	varchar	20	
	LT2	Advanced Laboratory test.	varchar	20	
	clinhis	Clinical history	varchar	60	

	Exam	Examination the patient	varchar	60	
	Invest	Investigation	varchar	60	
	Prob	Probability	varchar	60	
	Reason	Reason for referral	varchar	30	
	conditon	Condition of patient	varchar	30	
	Typ	Type of consultation	varchar	20	
	Ser_No	Service number	int	6	
	Ser_Name	Service name	varchar	50	
	Full_No	Full name of patient	Int	9	
	image		Varchar	50	

5.10.8 Data Base Scheme for Referral System



Ambulance table

Field	Type	Key
Amb_No	int(3)	
Amb_Name	varchar(30)	
Position	varchar(30)	
St_No	int(2)	pk 1
Loc_No	int(3)	
Tele	int(15)	

Doctor table

Field	Type	Key
D_No	int(9)	
D_Name	varchar(30)	
Ho_No	int(2)	
Un_No	int(3)	
Position	varchar(30)	Pk2

Hosser's table

Field	Type	Key
No	int(9)	
Name	varchar(20)	
Qlname	varchar(20)	
Qlname	varchar(20)	
Ho_No	int(3)	FKFK2

Hospital table

Field	Type	Key
Hs_No	int(3)	PK2
Ho_Name	varchar(60)	
Address	varchar(60)	
Type	varchar(35)	
Specialization	varchar(35)	
St_No	varchar(2)	FK 3
Loc_No	varchar(3)	
Telephone	varchar(15)	
Website	varchar(35)	
E-mail	varchar(35)	

Serrequest

Field	Type	Key
Req_No	int(9)	PK4
ser_no	int(9)	
file_no	varchar(20)	
Date	date	
Pat_Name	varchar(50)	
Mother_Name	varchar(50)	
Birth_date	date	
Gender	varchar(8)	
St_No	int(3)	Fk FR1,5
conc_Name	varchar(50)	
from_Do	varchar(40)	
un_no	varchar(30)	p
Position	varchar(50)	Fk fR3
Don_No	varchar(30)	
Ho_No_from	varchar(30)	
Ho_No_to	varchar(30)	
to_Do	varchar(30)	
Phos	varchar(20)	
BP	varchar(20)	
RP	varchar(20)	
Temp	varchar(20)	
RT1	varchar(20)	
RT2	varchar(20)	
LT1	varchar(20)	
LT2	varchar(20)	
clothis	varchar(60)	
Exam	varchar(60)	
Invest	varchar(60)	
Prob	varchar(60)	
Reason	varchar(30)	
condition	varchar(30)	
Typ	varchar(20)	

Service table

Field	Type	Null
Ser_No	int(6)	FK R4
Ser_Name	varchar(50)	
Ho_No	int(2)	
Un_No	int(3)	
Tell_No	int(9)	
Emr_No	int(9)	
image	varchar(50)	

Locality table

Field	Type	Key
Loc_No	int(2)	
Loc_Name	varchar(50)	
St_No	int(2)	PK5

State table

Field	Type	Key
St_No	int(2)	
St_Name	varchar(35)	FKR5

Units table

Field	Type	Key
un_no	int(3)	
un_name	varchar(50)	
Specialization	varchar(50)	
Ho_No	varchar(3)	

5.11 Discussion

It is evident that the e-Health Cloud presents promising opportunities for the healthcare industry which is still facing serious challenges? These challenges include patient care quality and safety, dramatically increasing healthcare costs, hardware costs and limitations, computing and access speeds, backup capabilities, security, resources scarcity; and most importantly, collaboration and knowledge sharing among healthcare professionals at local and international levels. As a result, the e-Health Cloud could be viewed as a suitable method to provide a potential solution to the value equation in the healthcare industry: “high quality services at the lowest cost.”

Adopting the e-Health Cloud to provide IT solutions for the healthcare industry comes with many advantages some of these include:

1. Reducing the cost of owning and maintaining an IT infrastructure and support personnel within each organization.
2. Providing better integration and exchange of medical records across multiple organizations and across sparse geographical areas.
3. Allowing multiple parties to benefit from the information repository to streamline processes, Enhance diagnosis, support medical research activities, and simplify administrative operations.

4. Increasing the availability, scalability and flexibility of the health information systems.

However, these benefits come with a high tax. Several issues and challenges need to be addressed before the e-Health Cloud is considered the best approach to take for healthcare providers. The major concern is security and privacy issues that need to be taken care of by several of the e-Health Cloud participants. However, the simple task of deciding who is responsible for which part is difficult and has no clear way of being done.

Yet, to make this referral a reality, the research community and the IT industry must put aside their differences and start working together to come up with efficient and workable solutions to the issues and challenges are currently facing.

5.12 Conclusions

The e-Health Cloud represents an enabling technology for many healthcare providers to face many challenges such as rising healthcare delivery costs, information sharing, and shortage of healthcare professionals. However, the benefits gained are offset by issues of trust, privacy, and security in addition to several technical issues that must be addressed before healthcare providers can fully adopt and trust the e-Health Cloud.

5.13 Snapshot of proposed referral system

Figure 5.1 login screen of the referral system.

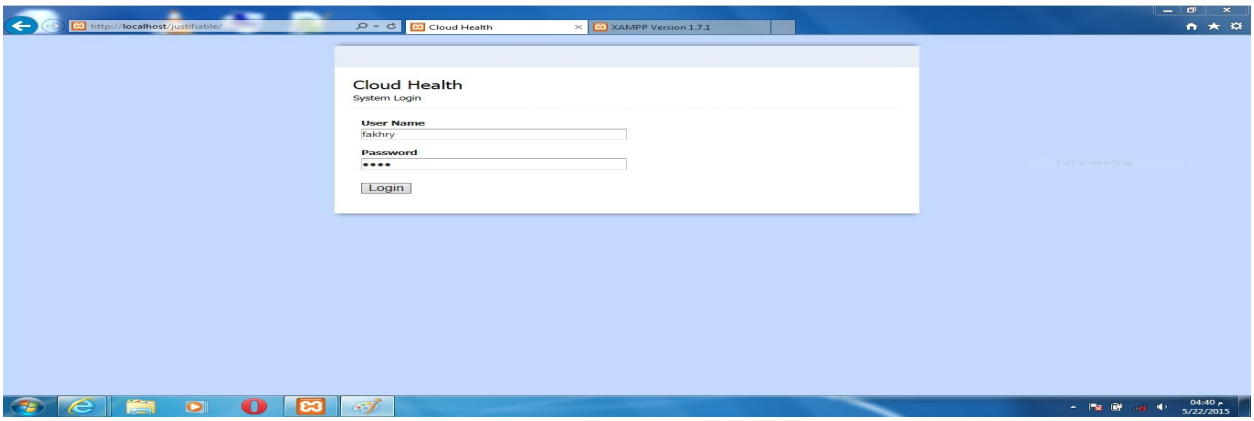


Figure 5.1 describe the login screen of a doctor who stays at area in one of four cases of the referral system.

Figure 5.2 describe the main four components of referral system and each one has sub sequence of units.

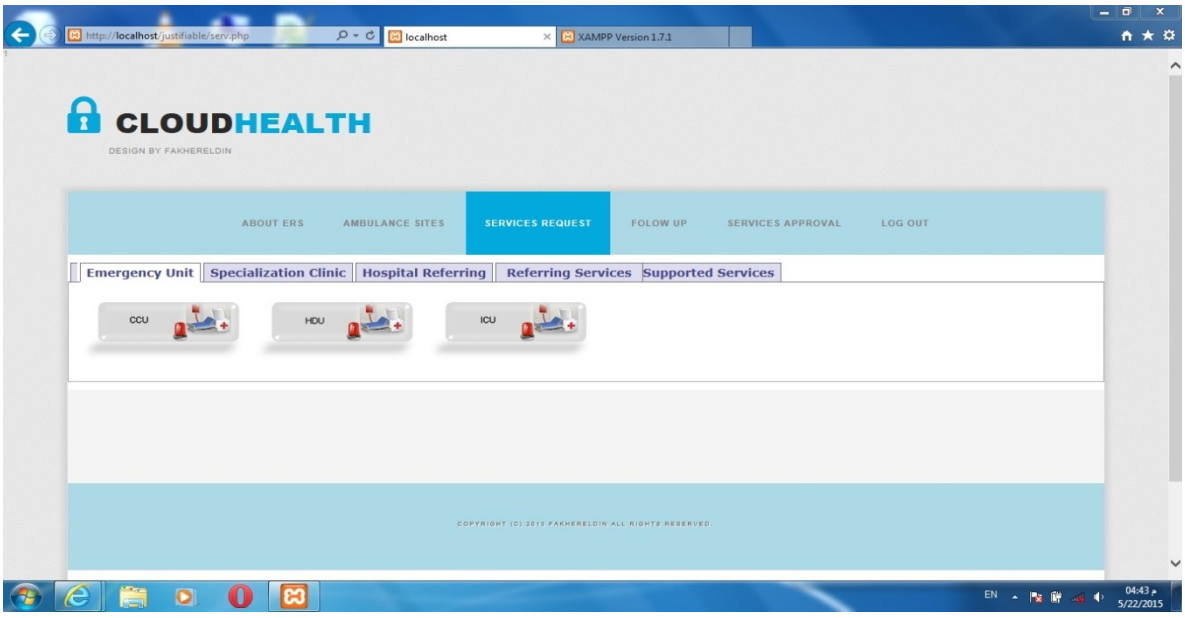


Figure 5.2 main four components of referral system

Figure 5.3 show the type of Service request emergency unit in this thesis present just three type there are (CCU, HDU and ICU).

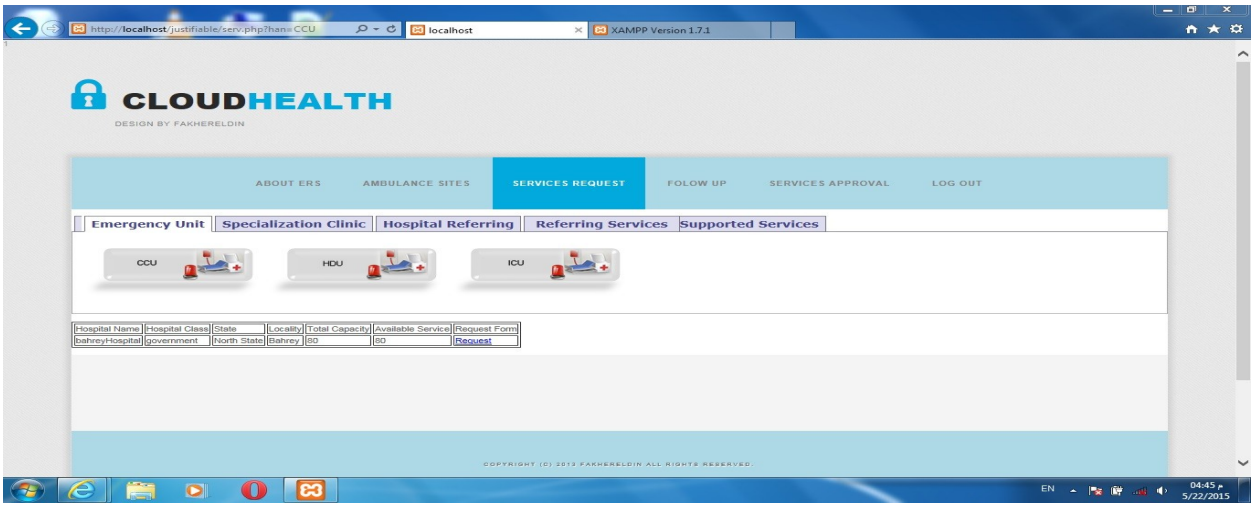


Figure 5.3 Service request emergency unit.

Figure 5.4 show sample of Service request supported services that the doctor may need it for mare investigations.

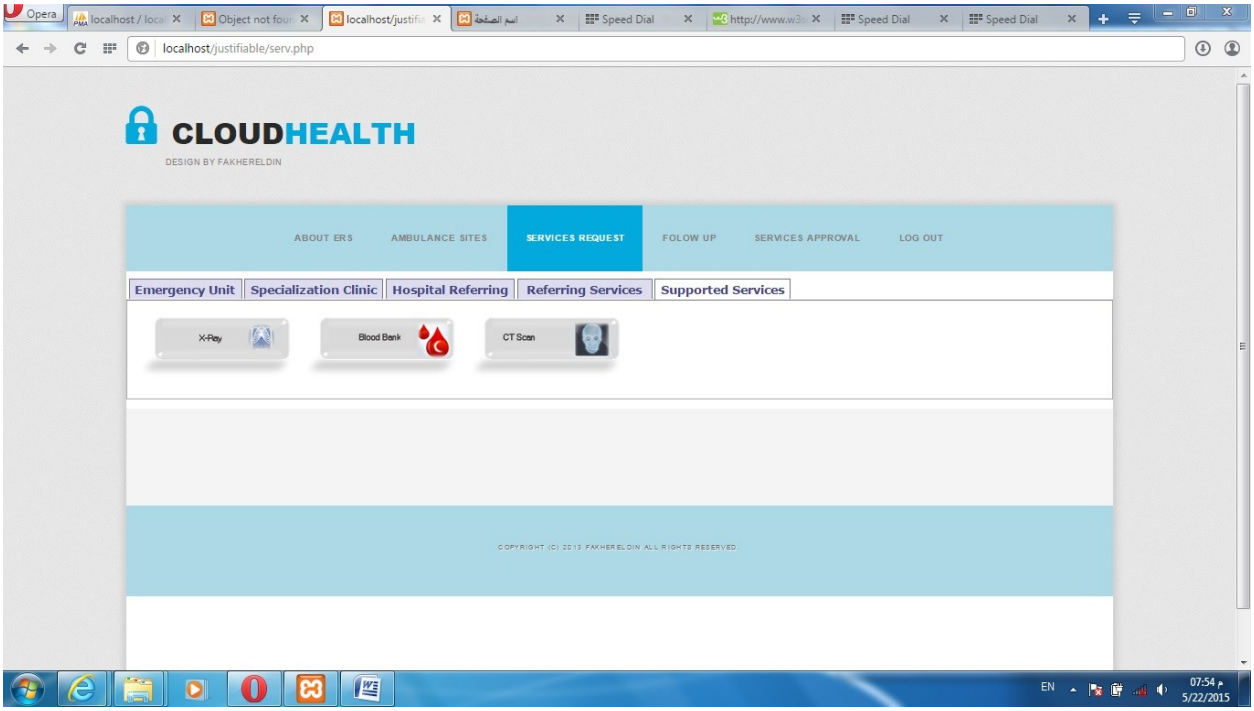


Figure 5.4 Service request supported services.

Figure 5.5 show Service request for one of three type referring services that included here

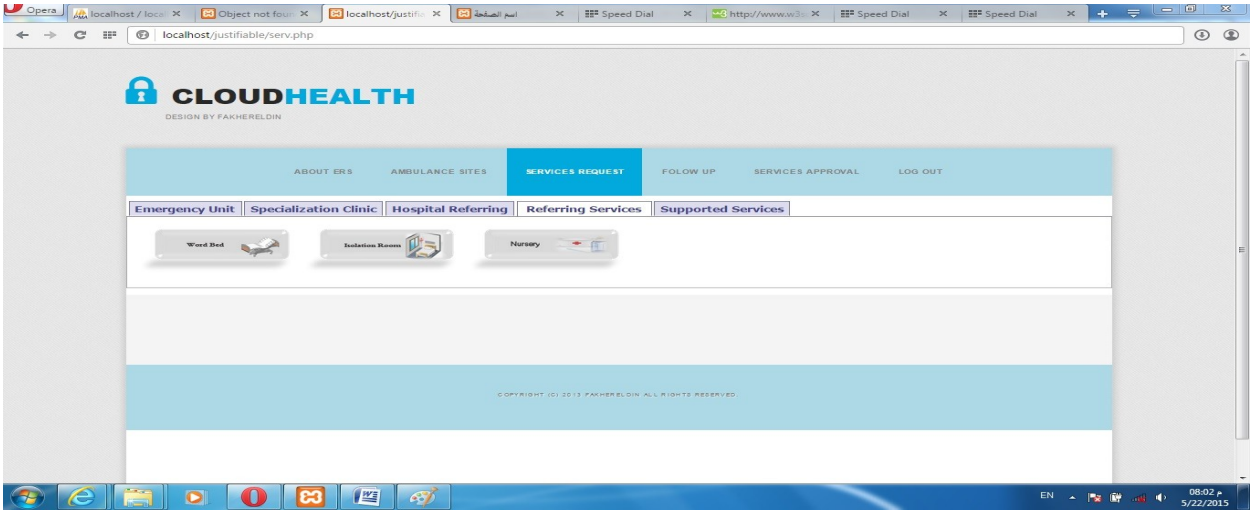


Figure 5.5 Service request referring services.

Figure 5.6 describe the Service request specialization clinic which doctor choose one of them or all to complete the treatment for referral case.

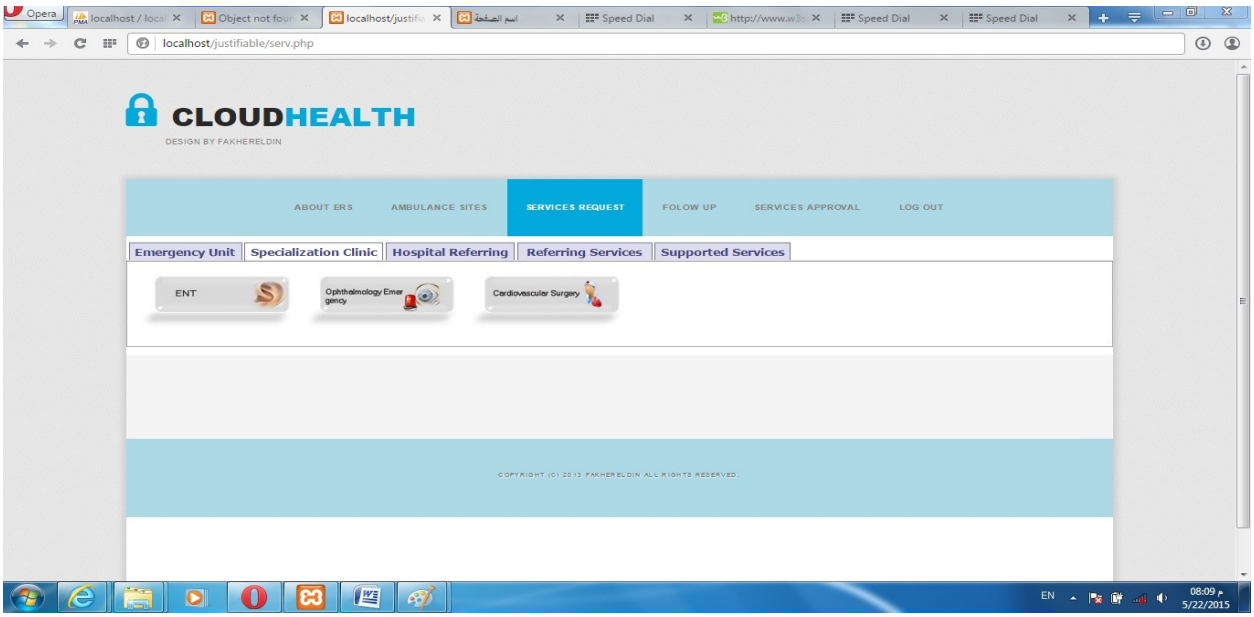


Figure 5.6 Service request specialization clinic.

Figure 5.7 **show** the purpose of **Service** request to hospital referring here CTscan is example.

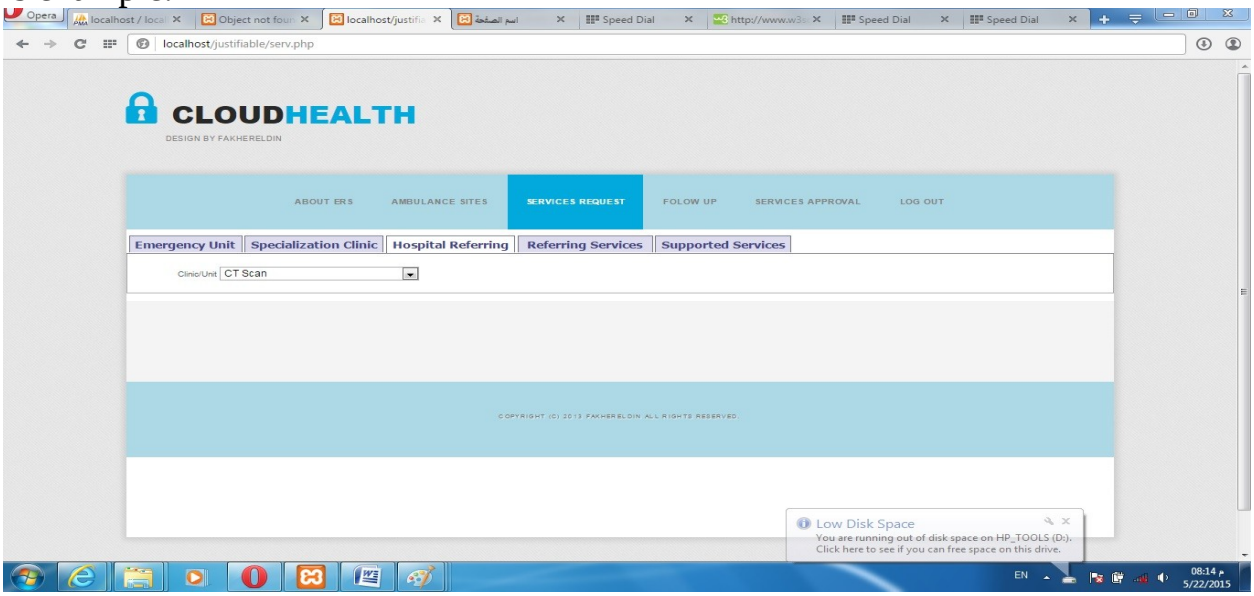


Figure 5.7 Service request hospital referring.

Figure 5.8 show the details of the Form that the doctor must fill it to service request include the state of patient.

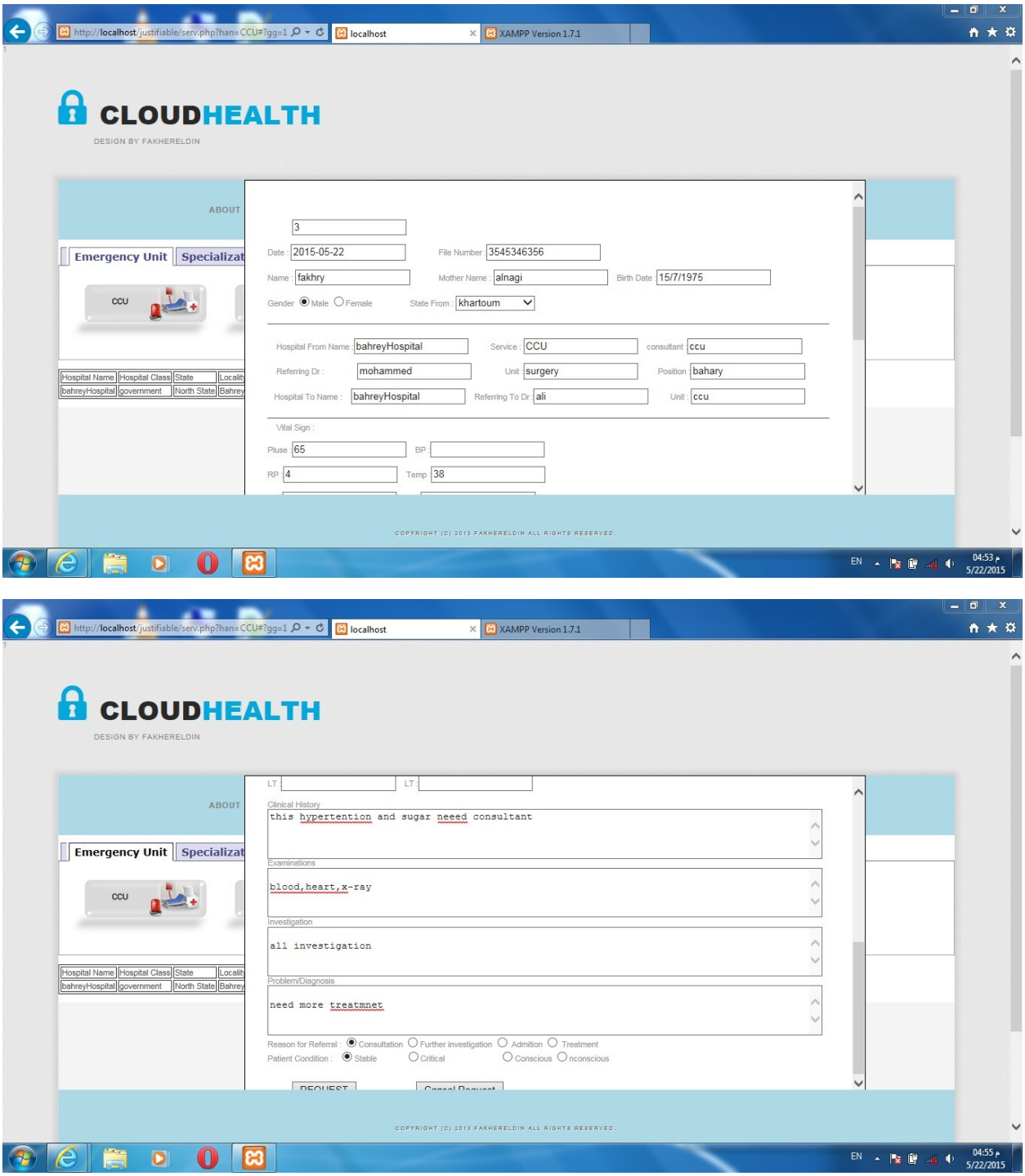
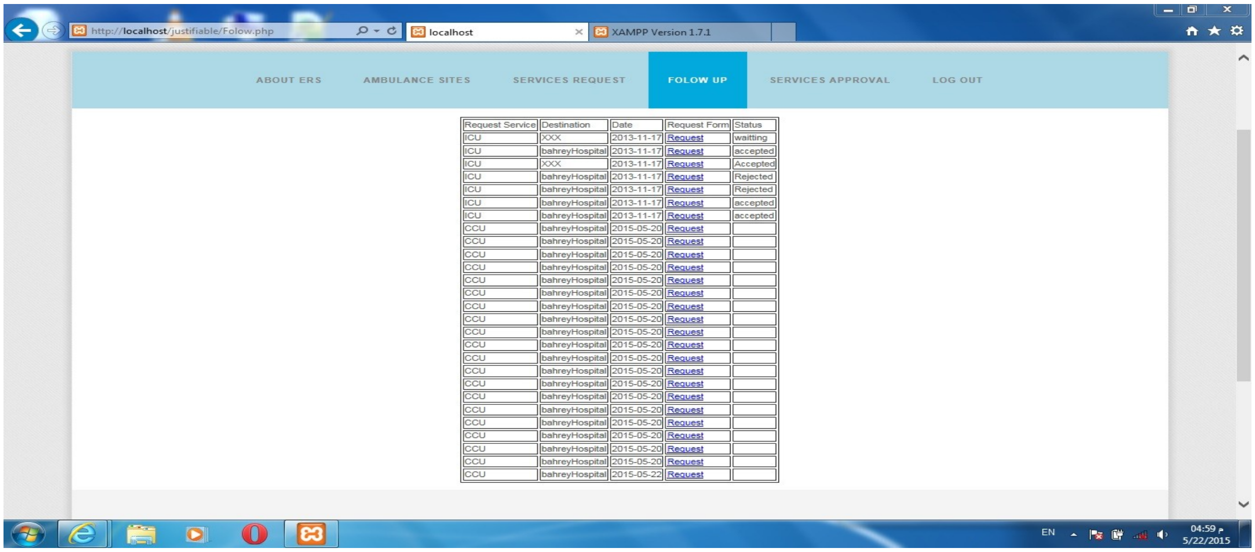


Figure 5.8 Form to show how service request.

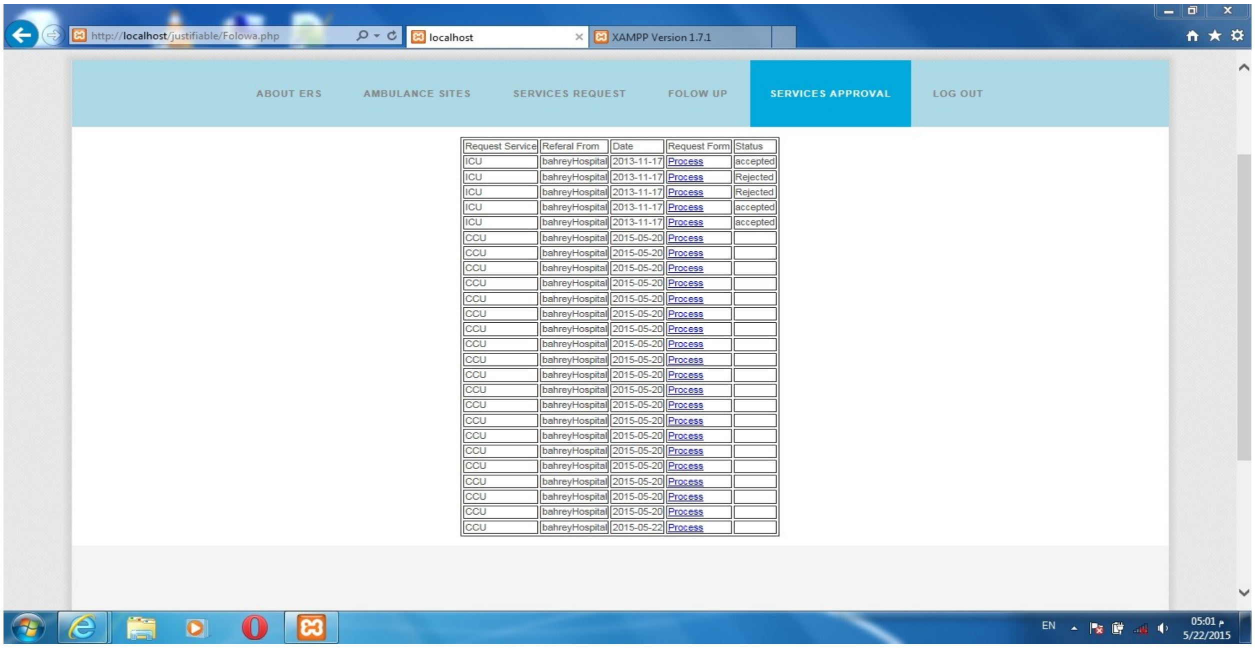
Figure 5.9 **show the** Follow **up service request which may be one of the three statuses (waiting, accept, or reject) the service.**



Request Service	Destination	Date	Request Form	Status
ICU	XXX	2013-11-17	Request	waitting
ICU	bahreyHospital	2013-11-17	Request	accepted
ICU	XXX	2013-11-17	Request	Accepted
ICU	bahreyHospital	2013-11-17	Request	Rejected
ICU	bahreyHospital	2013-11-17	Request	Rejected
ICU	bahreyHospital	2013-11-17	Request	accepted
ICU	bahreyHospital	2013-11-17	Request	accepted
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-20	Request	
CCU	bahreyHospital	2015-05-22	Request	

Figure 5.9 Follow up service request.

Figure 5.10 show when the service approval that mean it accepted or reject request.



Request Service	Referal From	Date	Request Form	Status
ICU	bahreyHospital	2013-11-17	Process	accepted
ICU	bahreyHospital	2013-11-17	Process	Rejected
ICU	bahreyHospital	2013-11-17	Process	Rejected
ICU	bahreyHospital	2013-11-17	Process	accepted
ICU	bahreyHospital	2013-11-17	Process	accepted
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-20	Process	
CCU	bahreyHospital	2015-05-22	Process	

Figure 5.10 Shows how service approval.

Figure 5.11 **show some sample of ambulance sites.**

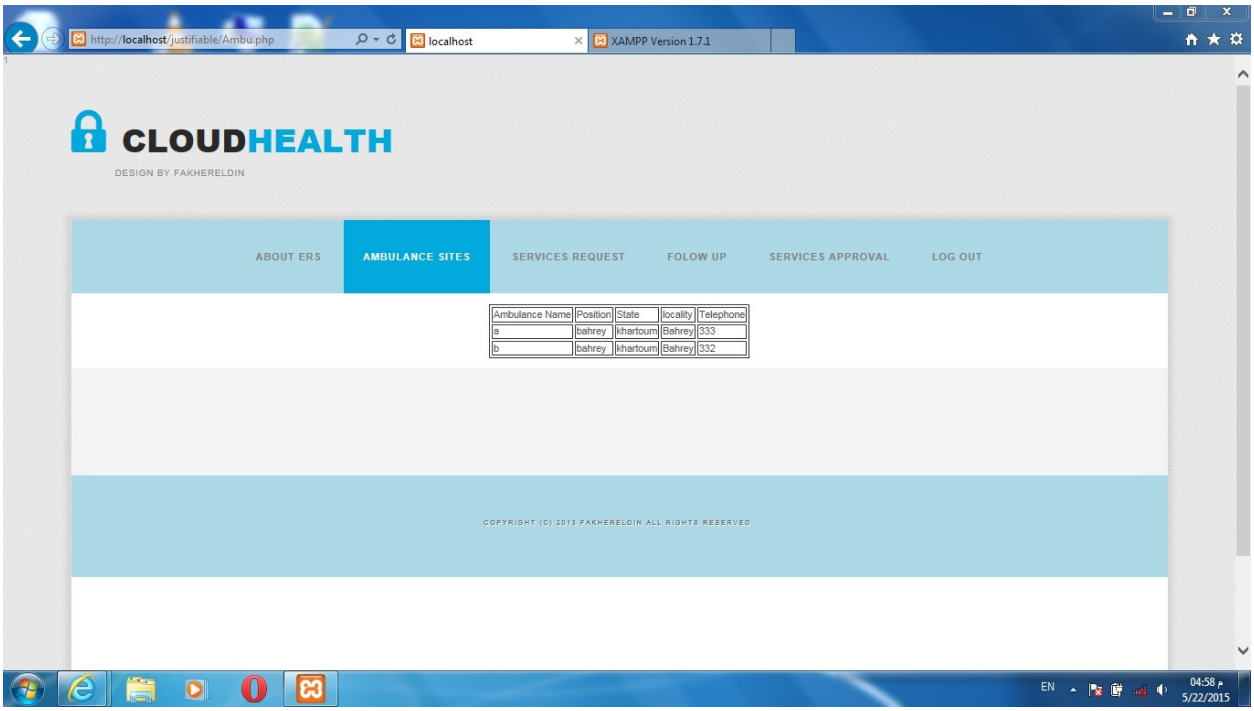


Figure 5.11 **Ambulance sites**

Figure 5.12 Describe sample of data in service request that fill by the doctor who referring patient and it store in database .

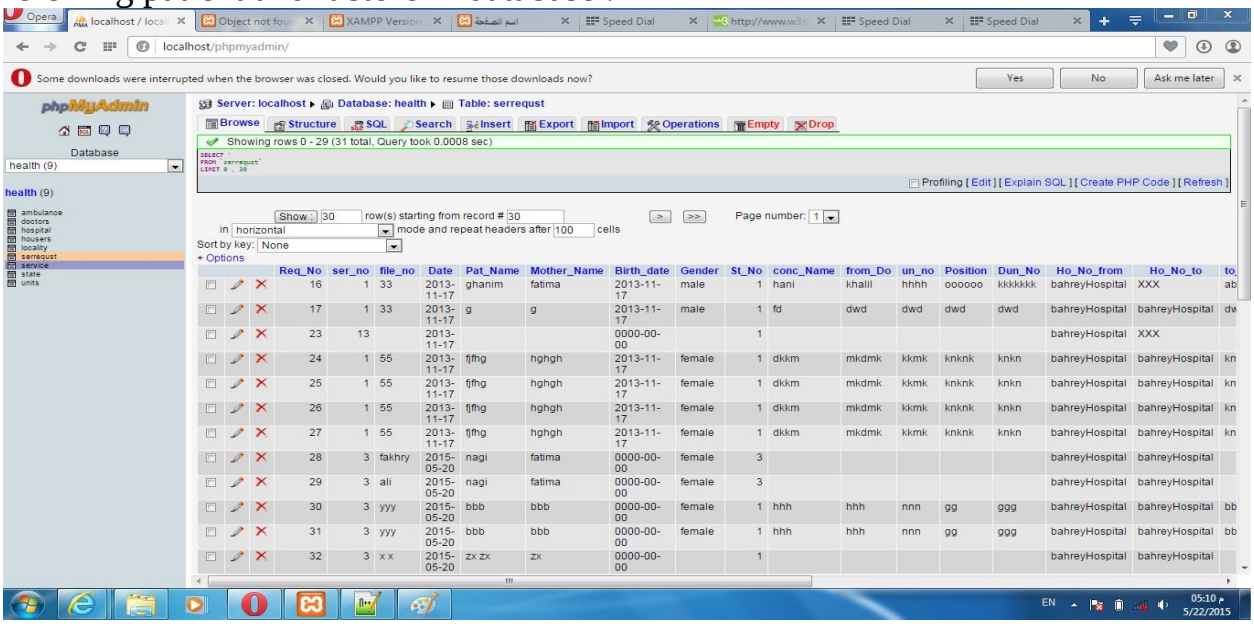


Figure 5.12 samples of data

Figure 5.13 sample of report which include the `Req_No`, `ser_no`, `Date`, `Pat_Name

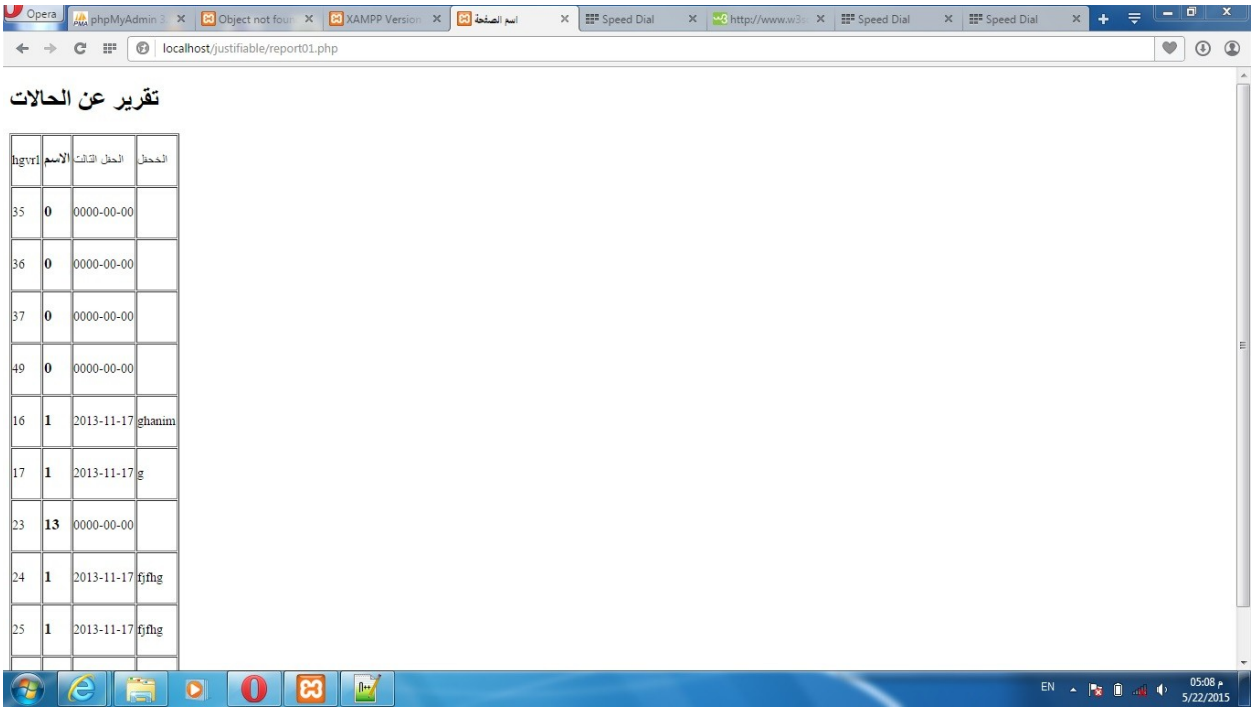


Figure 5.13 sample of report

CHAPTER SIX

Conclusion and Future work

6.1 Introduction

This chapter links thesis parts, such as problem statement, objectives, framework design and results, with the each other in conclusions section. In addition contributions are mentioned. Finally, future work and recommendations are stated.

As previously explained in chapter 1; the aim of the thesis is to design an effective cloud computing in health care services framework based on the past cloud computing used for the open stack. The research questions are:

i. What is the purpose of researching cloud computing in health care services areas?

ii. Why choose the cloud computing in health care services?

iii. Why use the most prominent cloud computing in health care services?

6.2 Contributions

The main contributions of this thesis are:

i. Comparing between most dominant of cloud computing in health care services and clarifying the advantages and disadvantages for each one of them.

ii. Proposing and designing a framework using different components of open stack to combine them as one in cloud environment.

iii. Write new system (referral system) and deploy it as a service in new cloud environment

6.3 The Results

The thesis had gone through different stages including problem identification, framework design, and validation/justification and results dissemination. The last stage for the thesis is result disseminations. In the problem identification there was a deep search of the importance of studying the health care services resulted in the comprehensive literature review that was made. Many experiments have shown that it is important to have health care services in designing cloud environment that reduces cost and increase the security. In the next stage, namely framework design, the three dominant steps were described in details. The comparison was done and the results shown that it is better to use Cisco or Google environments or prepare special cloud environment according to the needs. Moreover they were combined to design the framework and achieve the last objective of the thesis. The proposed framework had been justified to show its importance. Framework justification had shown that the components of open stack it was beneficial to the framework and presented referral system as a service. Now it is clear that the thesis answered all the questions, achieved the aim and satisfies the objectives.

6.4 Conclusion

This thesis concerns with design and implementation of a generic and secure architecture for cloud computing platforms. Open Stack being an open source platform with modularity in its architecture makes our work easier for testing and deploying central security system architecture.

In order to have efficient and significant discussion on benefits and issues of adopting cloud computing in e-Health, this thesis used literature review about Cisco, IBM, Microsoft and Google to show how they are implementing cloud computing in their environment using open stack.

Also, this thesis proposed cloud environment using open stack as cloud computing and write and apply one module of referral system as service.

There is a tremendous promise for cloud computing infrastructure in the healthcare industry. Cloud computing would help rural healthcare centers to achieve efficient use of their hardware and software investments and to increase profitability by improving the utilization of resources to the maximum. The purpose of implementing cloud computing systems in health care is not to compete with each other but serves to facilitate and improve the quality of patient care. There is no one system which is superior from the other but they have their own uniqueness. However, there is a need to synchronize these systems so that the system can communicate with other outside systems to ensure the maintenance and continuity of care.

Design and implementation of a generic and secure architecture for cloud computing platform is still an open issue in the field of security for IT organizations. Due to the different nature of computing platform, in terms of delivery and deployment models, cloud still needs generic and secure architecture in term of its adoption. And this thesis recognizes and achieves all objectives of it.

6.5 Future Work and Recommendations

6.5.1 Future Work

For the future work, the following issues can be achieved:

i. To demonstrate, implement and evaluate the proposed framework on real-world of cloud data or one of the online datasets.

ii. To compare between the proposed framework and other cloud computing in health care services.

iii. To propose a solution for the health care services problem in modified information-based on open stack using GIU.

6.5.2 Recommendations

Still there is a need to do more comprehensive observations and activities within this area. Some of them are listed below:

1) System architecture proposed has only been tested and deployed for SaaS platform. More observation and research can

be conducted for PaaS and IaaS platforms in order to verify the applicability of our architecture.

2) The overall performance of the system can also be evaluated in a scalable environment in order to identify throughput and latency of the system. Moreover the uptime and downtime of the system can be also be evaluated, and finally

3) Further expand the work to explore means of pooling various healthcare IT resources into large clouds so as to facilitate ease of record sharing, medical image processing, analysis, and diagnosis.

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List Appendixes

Appendix A Key terms

Appendix B Script for python language

(Just name of packages those changes in this thesis)

Appendix C Table for referral system.

Appendix D Open stack installation and configuration

Appendix A key terms

Cloud Computing: *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*‖ (Peter et al, 2009).

Community Cloud: This cloud is shared by a group of organizations and supports a specific community that has shared concerns. This may be managed by organizations or third party (Peter et al. 2009).

Data Center: A data center is a centralized repository on which software and data can be remotely stored instead of hard drive or a server located in user‘s premises (John. D. K et al, 2010)

e-Health: —e-Health as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, surveillance, literature and health education, knowledge and research (WHO).

Electronic Health Records (EHR): Establishing proper communication between patients, physicians, healthcare providers and health planners (Majid, 2008).

Electronic Medical Records (EMR): This is an electronic health care information record, which stores patient information with full interoperability within the enterprise. It connects different medical and technical departments (Haux, 2006).

Hybrid Cloud: The combination of private and public is called hybrid cloud (Peter et al. 2009).

Infrastructure as a Service: Users being able to use servers, storage, network settings on-demand from other providers on a pay-per-use basis (Peter et al. 2009).

Platform as a Service: The customer does not need to manage or control the cloud infrastructure including storage, networks, application, or operating systems but customer has control over the applications hosted configuration (Peter et al. 2009).

Private Cloud: Clouds that are used for specific organization providing more security and it may be managed by the organization or third party (Peter et al. 2009).

Public Cloud: Public cloud is owned by specific cloud service provider. This public cloud infrastructure is available for large organizations and public and can be accessed from anywhere (Peter et al. 2009).

Scalability: Maintaining the storage and traffic load in the peak load or high traffic for a site, cloud can handle easily without need of any additional hardware infrastructure or equipments and without disturbing user's normal work (Weiss, 2007).

Service Level Agreement (SLA): It is in general a legal binding agreement in the mutual understanding and acceptance about a service between a client who is buying the service and a Service Provider (David, 2009).

Service Provider (Vendor): Within the context of cloud computing, the service organization or provider is the business

that delivers a cloud computing application as a service for a monthly

Software as a Service: This service provides software and associated data centrally. It is easily accessed by the end users through thin client interface such as a web browser (Peter et al. 2009).

Appendix B Update Script for Python Language.

Python code: This code was written in order to deployment appropriate open stack. (Will be attached in CD) .

- ✓ Essex-AIO.sh
- ✓ folsom-AIO
- ✓ upload_cirros.sh
- ✓ upload_ttylinux
- ✓ remove
- ✓ readme

Appendix C Tables for Proposed Referral System in This Thesis:

```
-- phpMyAdmin SQL Dump
-- version 2.11.6
-- http://www.phpmyadmin.net
-- Host: localhost
-- Generation Time: Aug 01, 2014 at 04:12 PM
-- Server version: 5.0.51
-- PHP Version: 5.2.6

SET SQL_MODE="NO_AUTO_VALUE_ON_ZERO";


/*!40101 SET
@OLD_CHARACTER_SET_CLIENT=@@CHARACTER_SET_CLIENT */;
/*!40101 SET
@OLD_CHARACTER_SET_RESULTS=@@CHARACTER_SET_RESULTS */;
/*!40101 SET
@OLD_COLLATION_CONNECTION=@@COLLATION_CONNECTION */;
/*!40101 SET NAMES utf8 */;

-- Database: `health`

--
----------------------------------------------------------
-

-- Table structure for table `ambulance`

CREATE TABLE `ambulance` (
  `Am_No` int(3) NOT NULL auto_increment,
  `Am_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Position` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `St_No` int(2) NOT NULL,
  `Loc_No` int(3) NOT NULL,
  `Tele` int(15) NOT NULL,
```

```
  PRIMARY KEY  (`Am_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=3 ;

-- Dumping data for table `ambulance`

INSERT INTO `ambulance` (`Am_No`, `Am_Name`,
`Position`, `St_No`, `Loc_No`, `Tele`) VALUES
(1, 'a', 'bahrey', 1, 2, 333),
(2, 'b', 'bahrey', 1, 2, 332);

--
----------------------------------------------------------
-
-- Table structure for table `doctors`

CREATE TABLE `doctors` (
  `D_No` int(9) NOT NULL auto_increment,
  `D_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Ho_No` int(2) NOT NULL,
  `Un_No` int(3) NOT NULL,
  `Position` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  PRIMARY KEY  (`D_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=3 ;

-- Dumping data for table `doctors`

INSERT INTO `doctors` (`D_No`, `D_Name`, `Ho_No`,
`Un_No`, `Position`) VALUES
(1, 'ha', 1, 1, 'nnn'),
(2, 'ee', 1, 1, 'ww');

--
----------------------------------------------------------
-

-- Table structure for table `hospital`
```

```
CREATE TABLE `hospital` (
  `Ho_No` int(3) NOT NULL auto_increment,
  `Ho_Name` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Address` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Type` varchar(35) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Specialization` varchar(35) character set utf8
collate utf8_unicode_ci NOT NULL,
  `St_No` varchar(2) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Loc_No` varchar(3) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Telephone` varchar(15) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Website` varchar(35) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `E-mail` varchar(35) character set utf8 collate
utf8_unicode_ci NOT NULL,
  PRIMARY KEY  (`Ho_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=3 ;

-- Dumping data for table `hospital`

INSERT INTO `hospital` (`Ho_No`, `Ho_Name`, `Address`,
`Type`, `Specialization`, `St_No`, `Loc_No`,
`Telephone`, `Website`, `E-mail`) VALUES
(1, 'bahreyHospital', 'bahrey', 'government', 'ALL',
'1', '2', '234', 'ddd', 'dd'),
(2, 'XXX', 'bahrey', 'government', 'ALL', '1', '2',
'22', 'ss', 'ss');

--
----------------------------------------------------
-

-- Table structure for table `housers`
```

```
CREATE TABLE `housers` (
  `No` int(9) NOT NULL auto_increment,
  `Name` varchar(50) NOT NULL,
  `USname` varchar(50) NOT NULL,
  `USpass` varchar(50) NOT NULL,
  `Ho_No` int(3) NOT NULL,
  PRIMARY KEY  (`No`),
  KEY `Ho_No` (`Ho_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=2 ;

-- Dumping data for table `housers`

INSERT INTO `housers` (`No`, `Name`, `USname`,
`USpass`, `Ho_No`) VALUES
(1, 'fakh', 'fakh', '1234', 1);

--
----------------------------------------------------------
-

-- Table structure for table `locality`

CREATE TABLE `locality` (
  `Loc_No` int(2) NOT NULL auto_increment,
  `Loc_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `St_No` int(2) NOT NULL,
  PRIMARY KEY  (`Loc_No`,`St_No`),
  KEY `St_No` (`St_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=3 ;

-- Dumping data for table `locality`

INSERT INTO `locality` (`Loc_No`, `Loc_Name`, `St_No`)
VALUES
(1, 'khartoum', 1),
(2, 'Bahrey', 1);
```

```
--
-------------------------------------------------------
-

-- Table structure for table `serrequst`

CREATE TABLE `serrequst` (
  `Req_No` int(9) NOT NULL auto_increment,
  `ser_no` int(9) NOT NULL,
  `file_no` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Date` date NOT NULL,
  `Pat_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Mother_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Birth_date` date NOT NULL,
  `Gender` varchar(8) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `St_No` int(3) NOT NULL,
  `conc_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `from_Do` varchar(40) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `un_no` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Position` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Dun_No` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Ho_No_from` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Ho_No_to` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `to_Do` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Pluse` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
```

```
  `BP` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `RP` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Temp` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `RT1` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `RT2` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `LT1` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `LT2` varchar(20) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `clinhis` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `exam` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `invest` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `prob` varchar(60) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Reason` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `conditon` varchar(30) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `typ` varchar(20) NOT NULL,
  PRIMARY KEY  (`Req_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=28 ;

-- Dumping data for table `serrequst`

INSERT INTO `serrequst` (`Req_No`, `ser_no`, `file_no`,
`Date`, `Pat_Name`, `Mother_Name`, `Birth_date`,
`Gender`, `St_No`, `conc_Name`, `from_Do`, `un_no`,
`Position`, `Dun_No`, `Ho_No_from`, `Ho_No_to`,
`to_Do`, `Pluse`, `BP`, `RP`, `Temp`, `RT1`, `RT2`,
`LT1`, `LT2`, `clinhis`, `exam`, `invest`, `prob`,
`Reason`, `conditon`, `typ`) VALUES
```

```
(16, 1, '33', '2013-11-17', 'ghanim', 'fatima', '2013-
11-17', 'male', 1, 'hani', 'khalil', 'hhhh', 'oooooo',
'kkkkkkk', 'bahreyHospital', 'XXX', 'abdu', 'a', 'b',
'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j', 'k', 'l', 'm',
'n', 'waitting'),
(17, 1, '33', '2013-11-17', 'g', 'g', '2013-11-17',
'male', 1, 'fd', 'dwd', 'dwd', 'dwd', 'dwd',
'bahreyHospital', 'bahreyHospital', 'dwd', '', '', '',
'', '', '', '', '', '', '', '', '', '', '', '',
'accepted'),
(23, 13, '', '2013-11-17', '', '', '0000-00-00', '', 1,
'', '', '', '', '', 'bahreyHospital', 'XXX', '', 'a',
'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i\r\n', 'j\r\n',
'k\r\n', 'l\r\n', '', '', 'Accepted'),
(24, 1, '55', '2013-11-17', 'fjfhg', 'hghgh', '2013-11-
17', 'female', 1, 'dkkm', 'mkdmk', 'kkmk', 'knknk',
'knkn', 'bahreyHospital', 'bahreyHospital', 'knkn',
'k', 'd', 'u', 't', 'i', 'l', 'm', 'p', 'f\r\n',
'y\r\n', 'z\r\n', 'a\r\n', '', '', 'Rejected'),
(25, 1, '55', '2013-11-17', 'fjfhg', 'hghgh', '2013-11-
17', 'female', 1, 'dkkm', 'mkdmk', 'kkmk', 'knknk',
'knkn', 'bahreyHospital', 'bahreyHospital', 'knkn',
'k', 'd', 'u', 't', 'i', 'l', 'm', 'p', 'f\r\n',
'y\r\n', 'z\r\n', 'a\r\n', 'Treatment', '',
'Rejected'),
(26, 1, '55', '2013-11-17', 'fjfhg', 'hghgh', '2013-11-
17', 'female', 1, 'dkkm', 'mkdmk', 'kkmk', 'knknk',
'knkn', 'bahreyHospital', 'bahreyHospital', 'knkn',
'k', 'd', 'u', 't', 'i', 'l', 'm', 'p', 'f\r\n',
'y\r\n', 'z\r\n', 'a\r\n', 'Treatment', 'Treatment',
'accepted'),
(27, 1, '55', '2013-11-17', 'fjfhg', 'hghgh', '2013-11-
17', 'female', 1, 'dkkm', 'mkdmk', 'kkmk', 'knknk',
'knkn', 'bahreyHospital', 'bahreyHospital', 'knkn',
'k', 'd', 'u', 't', 'i', 'l', 'm', 'p', 'f\r\n',
'y\r\n', 'z\r\n', 'a\r\n', 'Treatment', 'nconscious',
'accepted');
```

```
--
-----------------------------------------------------
-

-- Table structure for table `service`

CREATE TABLE `service` (
  `Ser_No` int(6) NOT NULL auto_increment,
  `Ser_Name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Ho_No` int(2) NOT NULL,
  `Un_No` int(3) NOT NULL,
  `Full_No` int(9) NOT NULL,
  `Free_No` int(9) NOT NULL,
  `image` varchar(50) NOT NULL,
  PRIMARY KEY  (`Ser_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=14 ;

-- Dumping data for table `service`

INSERT INTO `service` (`Ser_No`, `Ser_Name`, `Ho_No`,
`Un_No`, `Full_No`, `Free_No`, `image`) VALUES
(1, 'ICU', 1, 1, 80, 80, 'ICUL_1.png'),
(2, 'HDU', 1, 1, 80, 80, 'HDU_1.png'),
(3, 'CCU', 1, 1, 80, 80, 'CCUL_1.png'),
(4, 'cardiovascular', 1, 2, 80, 80, 'cardL_1.png'),
(5, 'Ophthalmology emergency', 1, 2, 80, 80,
'eyeEML_1.png'),
(6, 'ENT', 1, 2, 80, 80, 'ent.png'),
(7, 'CT Scan', 1, 5, 80, 80, 'd3.png'),
(8, 'Blood Bank', 1, 5, 80, 80, 'd2.png'),
(9, 'X-Ray', 1, 5, 80, 80, 'd1.png'),
(10, 'Nursery', 1, 4, 80, 80, 'c3.png'),
(11, 'Isolation Room', 1, 4, 80, 80, 'c2.png'),
(12, 'Word Bed', 1, 4, 80, 80, 'c1.png'),
(13, 'ICU', 2, 1, 80, 80, 'ICUL_1.png');
```

```
--
--------------------------------------------------------
-

-- Table structure for table `state`

CREATE TABLE `state` (
  `St_No` int(2) NOT NULL auto_increment,
  `St_Name` varchar(35) character set utf8 collate
utf8_unicode_ci NOT NULL,
  PRIMARY KEY  (`St_No`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=5 ;

-- Dumping data for table `state`

INSERT INTO `state` (`St_No`, `St_Name`) VALUES
(1, 'khartoum'),
(2, 'North State'),
(3, 'red sea'),
(4, 'Kasala');

--
--------------------------------------------------------
-
-- Table structure for table `units`

CREATE TABLE `units` (
  `un_no` int(3) NOT NULL auto_increment,
  `un_name` varchar(50) character set utf8 collate
utf8_unicode_ci NOT NULL,
  `Specialization` varchar(50) character set utf8
collate utf8_unicode_ci NOT NULL,
  `Ho_No` varchar(3) character set utf8 collate
utf8_unicode_ci NOT NULL,
  PRIMARY KEY  (`un_no`)
) ENGINE=InnoDB  DEFAULT CHARSET=latin1
AUTO_INCREMENT=18 ;

-- Dumping data for table `units`
```

```
INSERT INTO `units` (`un_no`, `un_name`,
`Specialization`, `Ho_No`) VALUES
(1, 'Emergency Unit', 'Emergency', '1'),
(2, 'Specialization Clinic', 'Clinic', '1'),
(3, 'Hospital Referring', 'Referring', '1'),
(4, 'Referring Services', 'Referring Services', '1'),
(5, 'Supported Services ', 'Supported Services ', '1'),
(13, 'Emergency Unit', 'Emergency', '2'),
(14, 'Specialization Clinic', 'Clinic', '2'),
(16, 'Supported Services', 'Support Service', '2'),
(17, 'Hospital Reefering', 'Hospital Reefering', '2');

-- Constraints for dumped tables
--
-- Constraints for table `housers`
--LTER TABLE `housers`
  ADD CONSTRAINT `housers_ibfk_1` FOREIGN KEY (`Ho_No`)
REFERENCES `hospital` (`Ho_No`) ON DELETE CASCADE ON
UPDATE CASCADE;

--Constraints for table `locality`
--
ALTER TABLE `locality`
  ADD CONSTRAINT `locality_ibfk_1` FOREIGN KEY
(`St_No`) REFERENCES `state` (`St_No`) ON DELETE
CASCADE ON UPDATE CASCADE;
```

Appendix D Steps to Install and Configure Open Stack Environment

To install open stack in this thesis need two (NIC) card which is provide virtually through virtual box program:

1. NAT network: that represent the original network for the system include ip for system and use to communicate with external network and system, but it was not used in this study.
2. Host –only network: that deal with internal network and use ip to install open stack.

In order to deploy open stack with special environment Also need to write script (using python language)

The following screens shows how to setting up and configure network to install open stack in this thesis.

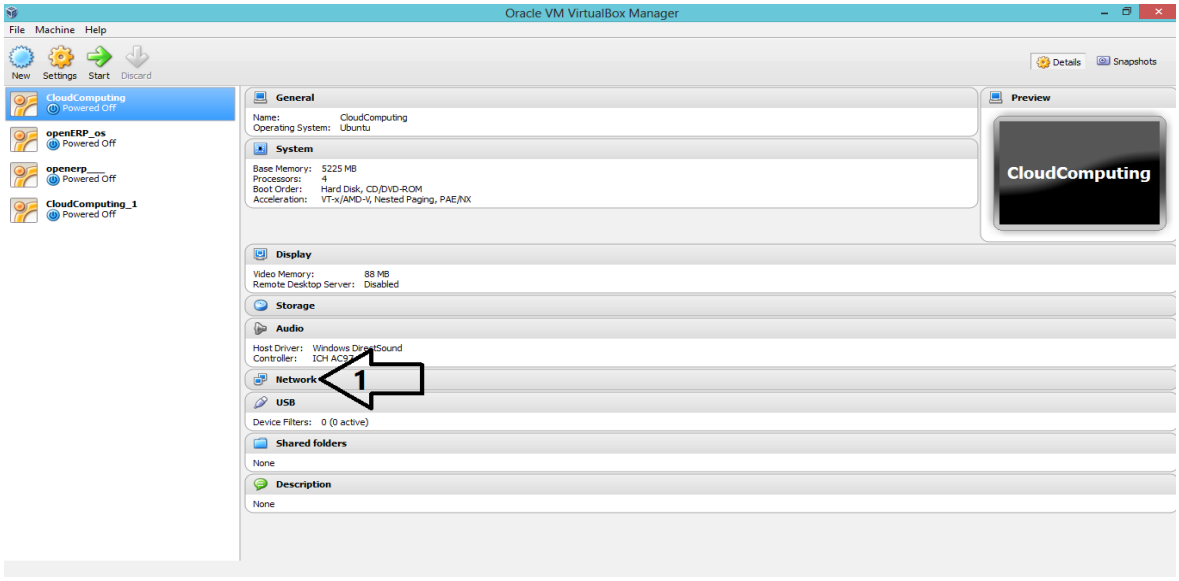


Figure D.1 Setting and manage network.

Figure D.1 shows the network configuration inside the cloud computing.

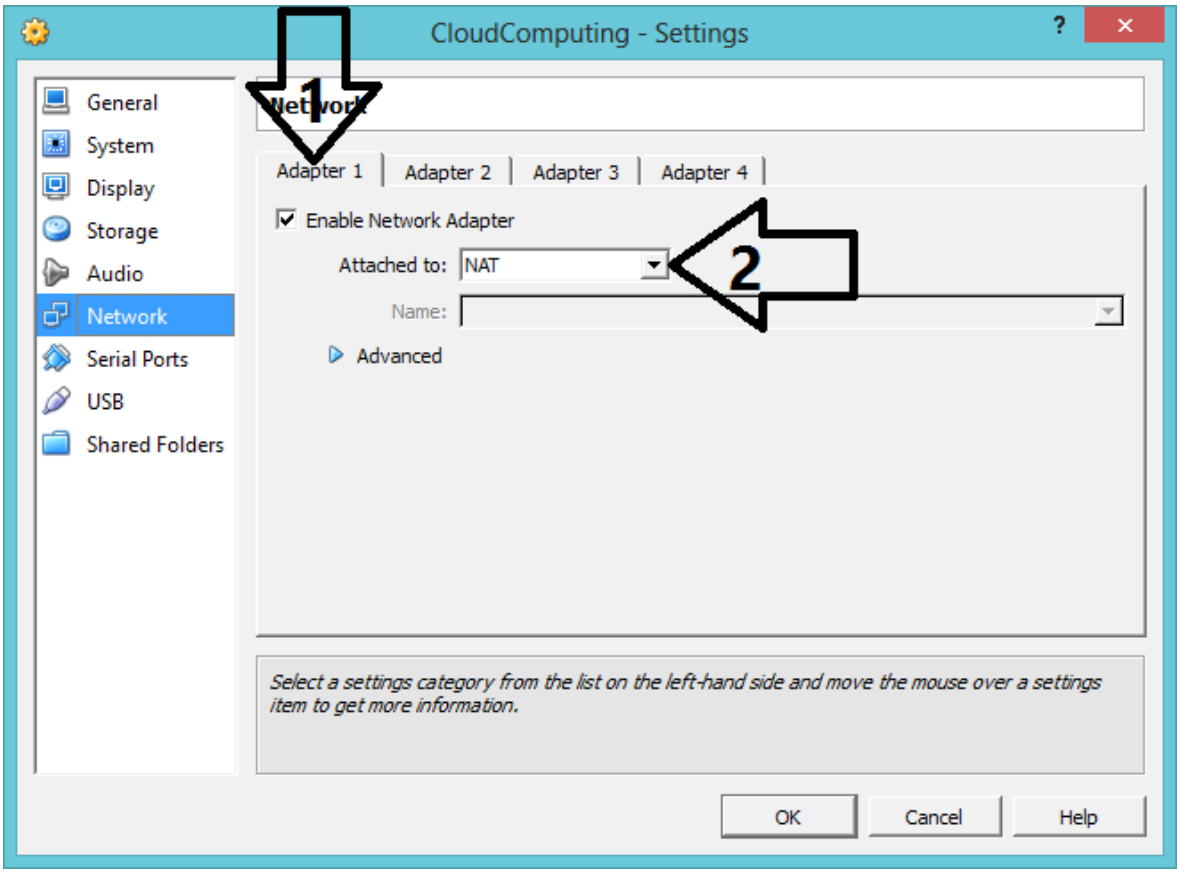


Figure D.2 Setting and manage network – build NAT.

Figure D.2 describe the adapter that uses to configure it as network address translation.

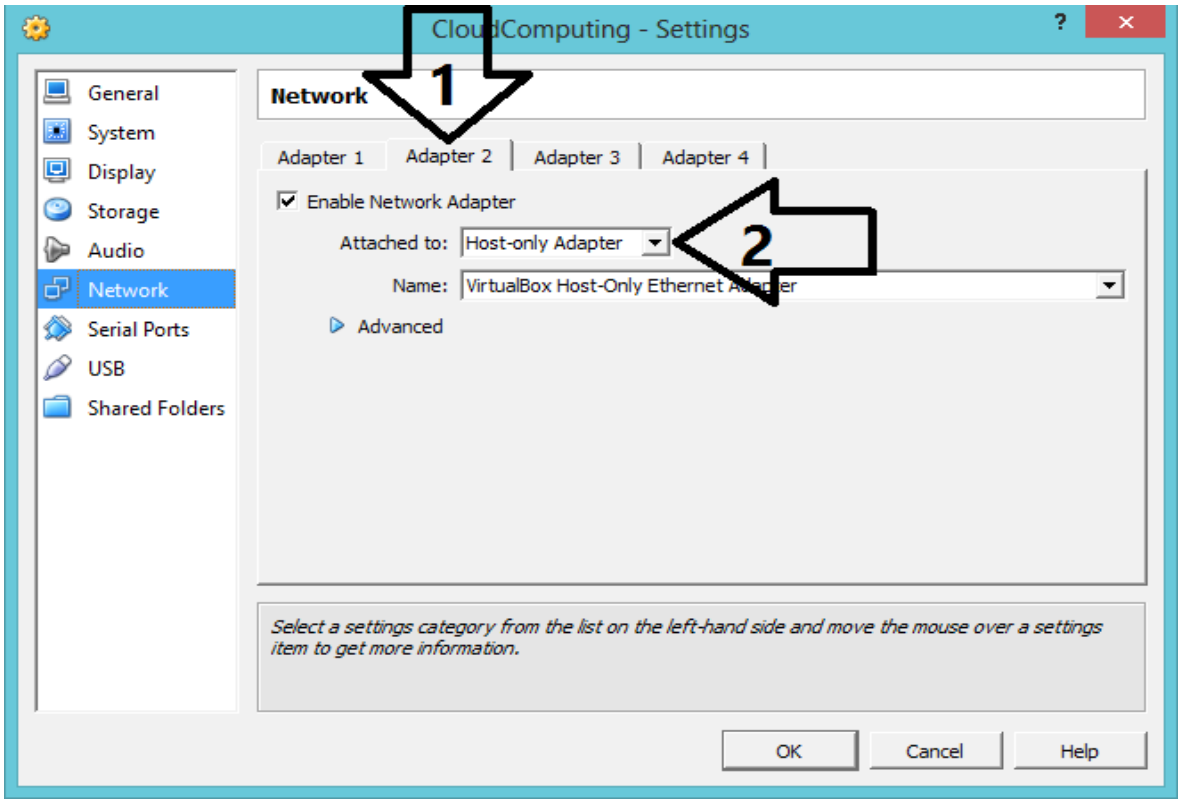


Figure D.3 Setting and manage network – build Host-Only.

Figure D.3 shows the adapter which set as host only and this Ethernet just the cloud deal with it.

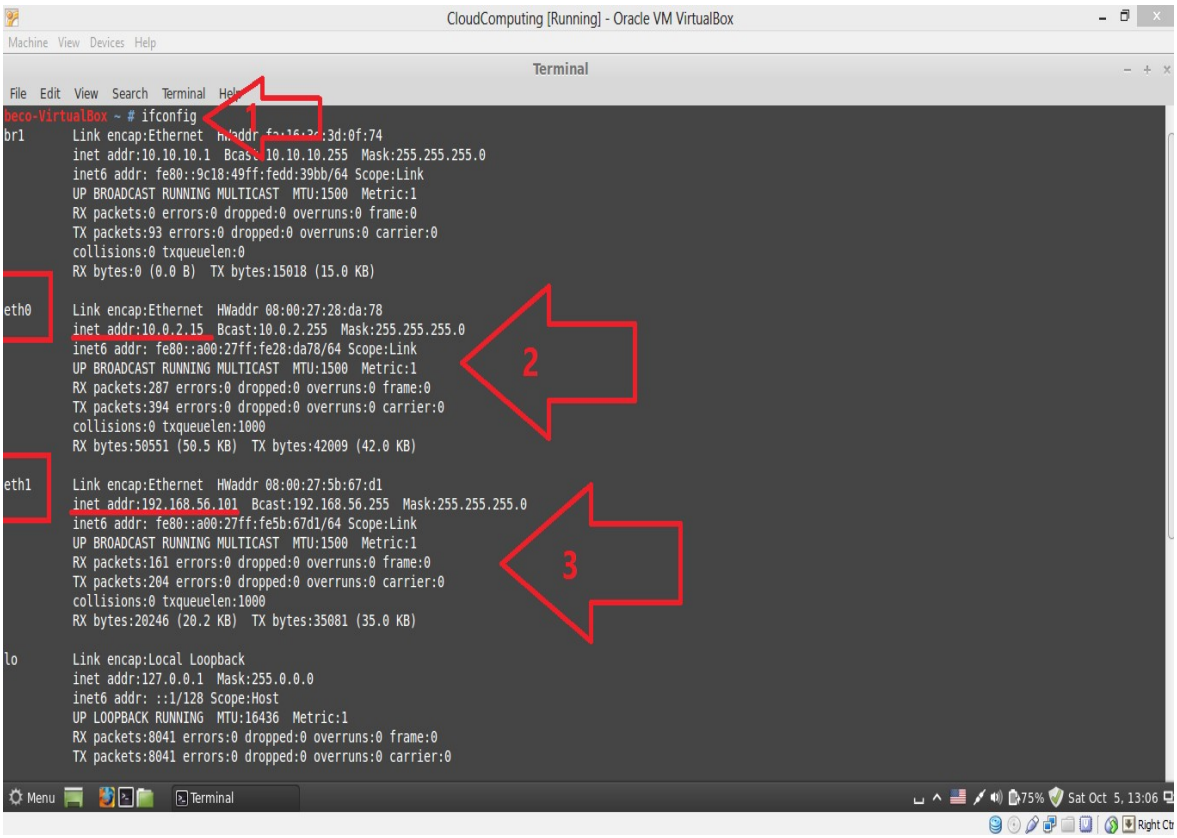


Figure D.4 Show the setting from internal Linux (ubuntu 12.04 LTS)

Figure D.4 shows how to view setting of network from internal operating system using command *ifconfig* then display the network which represent the original NAT network and their *ip* which is use to communicate to other system of network, and it not required to install open stack .However, the eth1 network which is represent host – only network and inter *ip* which is use to install open stack.

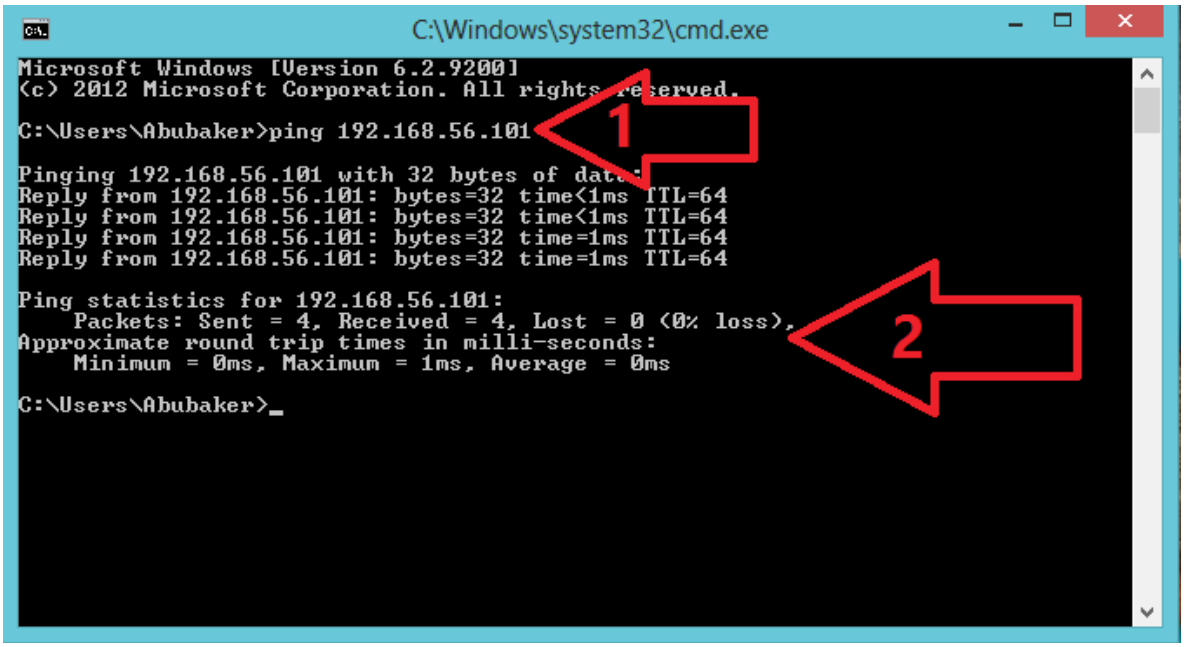


Figure D.5 Test ip from inside hosting device.

Figure D.5 describes communicate testing of eth1network (host – only network) from inside host device to insure that the ability to reach internal network through this hosting device.

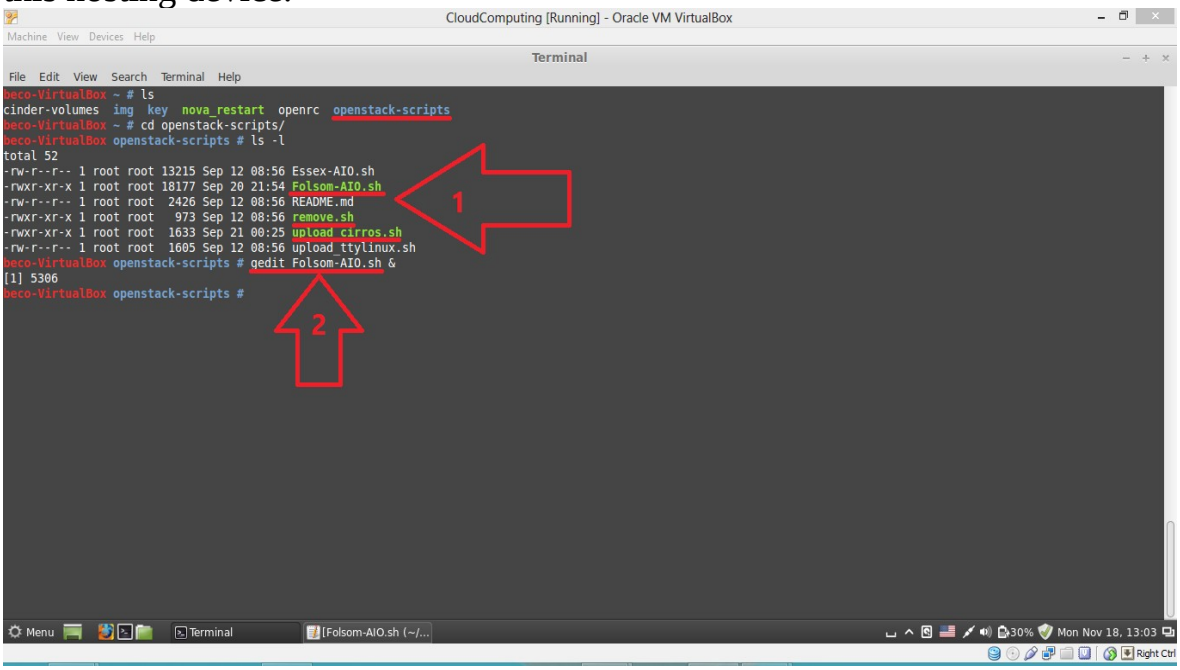


Figure D.6 Location and component of open stack scripts folder.

Figure D.6 describes the open stack scripts folder location with system folder after install it in the system and this folder consist the following basic files: (find the script in the appendix)

1. **Folsom –ALO.sh file:** This is shell script file consist of all special command uses to install Folsom open stack component.
2. **Remove .sh file:** This is shell script file consist of special command uses to uninstall Folsom open stack.
3. **Upload_cirros.sh file:** It is simple system build on Linux has very small size, and the main purpose to test open stack work after installed.

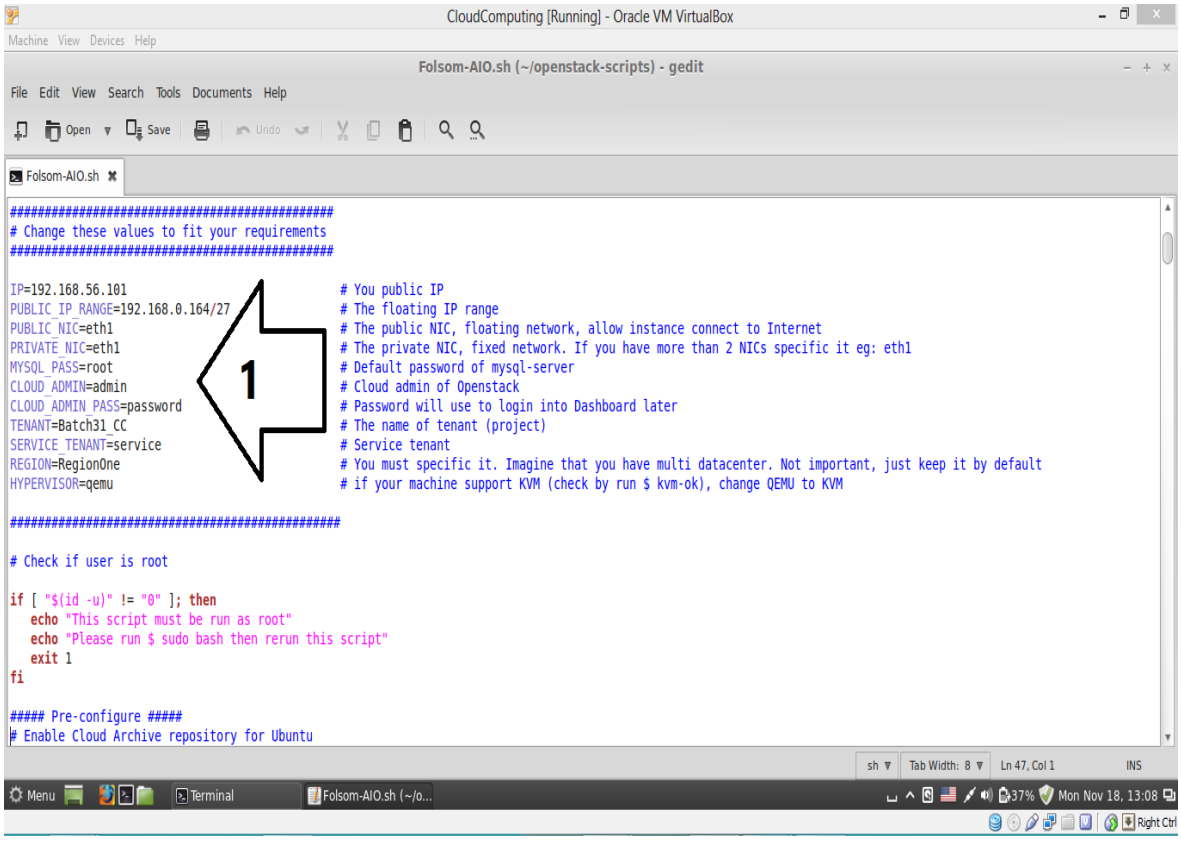


Figure D.7 Shows some important setting inside Folsom –ALO.sh file.

Before execute Folsom –ALO.sh file there are some important setting must do it on this file:

- **Setting ip:** Must add ip for host- only network which is mention later and we need it at this setting ip
- **Setting private _NIC and public _NIC:** Here I write network name specified for hosting only, eth1.
- **Setting MYSQL _pass:** At this practical is root.
- **Setting cloud _admin:** At this practical is admin**.**
- **Setting cloud _admin pass:** At this practical is password
- **Setting tenant:** Which is represent name, or address of open stack system, at this practical is Batch31_CC.

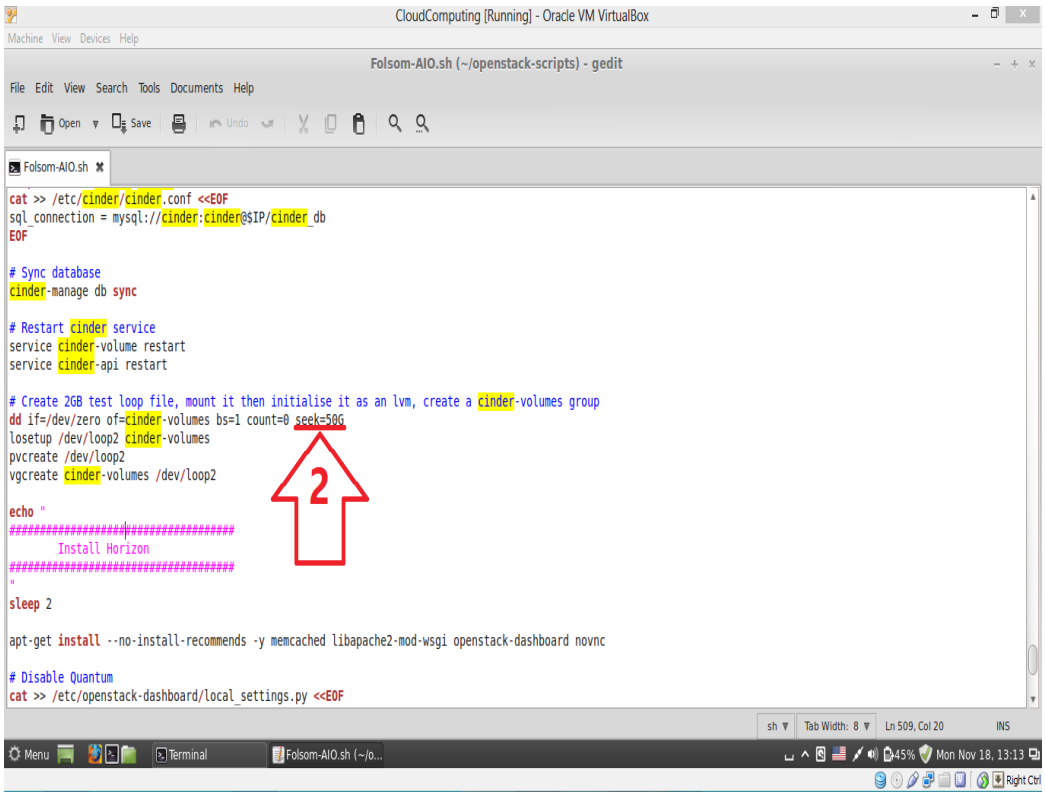


Figure D.8: Shows some important setting inside Folsom –ALO.sh file.

Figure D.8 describes cinder setting which is one of the basic open stack components; use to specify extra size on hard disk drive. This size specified to upload images in open stack system.

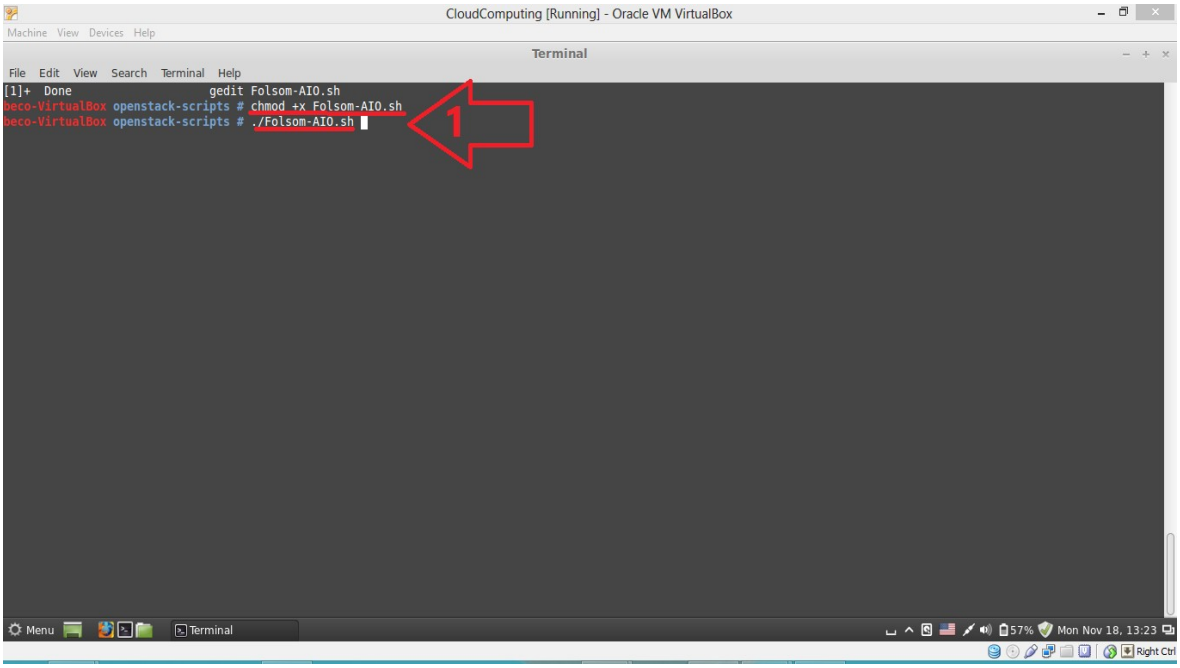


Figure D.9 executes Folsom –ALO.sh file

Figure D.9 show the **executes Folsom –ALO.sh file in order to run open stack** After complete the important setting at Folsom-ALO file, and then execute it through these steps:

- give this file permission to execute through this command.

Chomd+x folson-ALO.sh

- execute it using command

./folson-ALO.sh

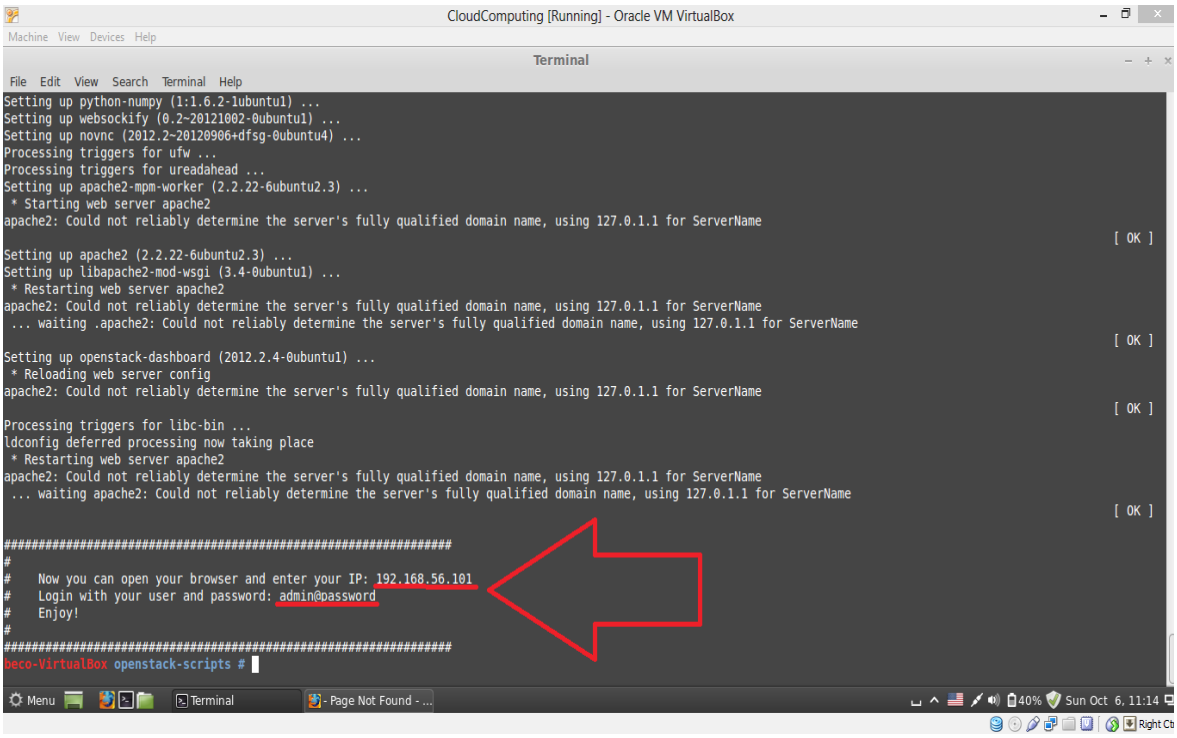


Figure D.10 Shows result of executing Folsom –ALO.sh command.

Figure D.10 show the result executes ./folson-ALO.sh command which use to install open stack system, and it contains the following basic information:

- ip which is use to login to open stack and it written in navigation toolbar to browse the main interface of open stack .
- Username: here is admin which is set it later at folson-ALO.sh file.
- Password: here is password which is set it later at folson-ALO.sh file.

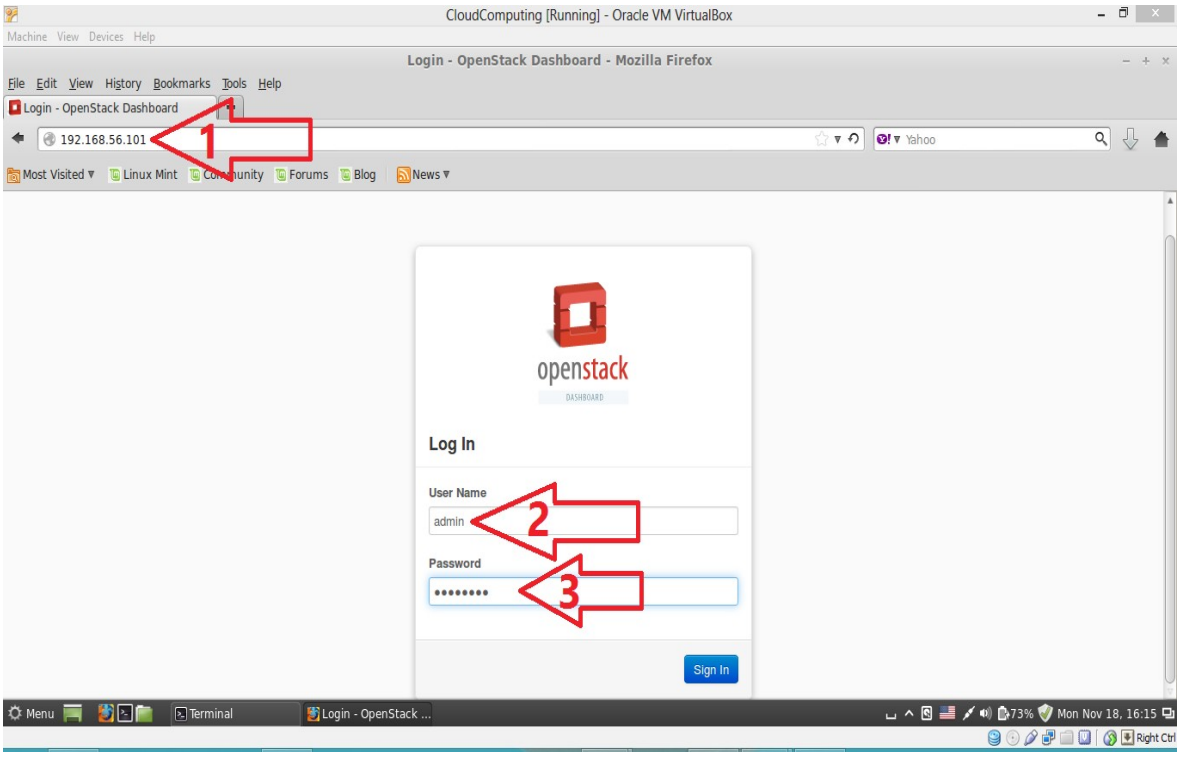


Figure D.11 open stack login interface.

Figure D.11 describes open stack login interface which include some information like user name and password.

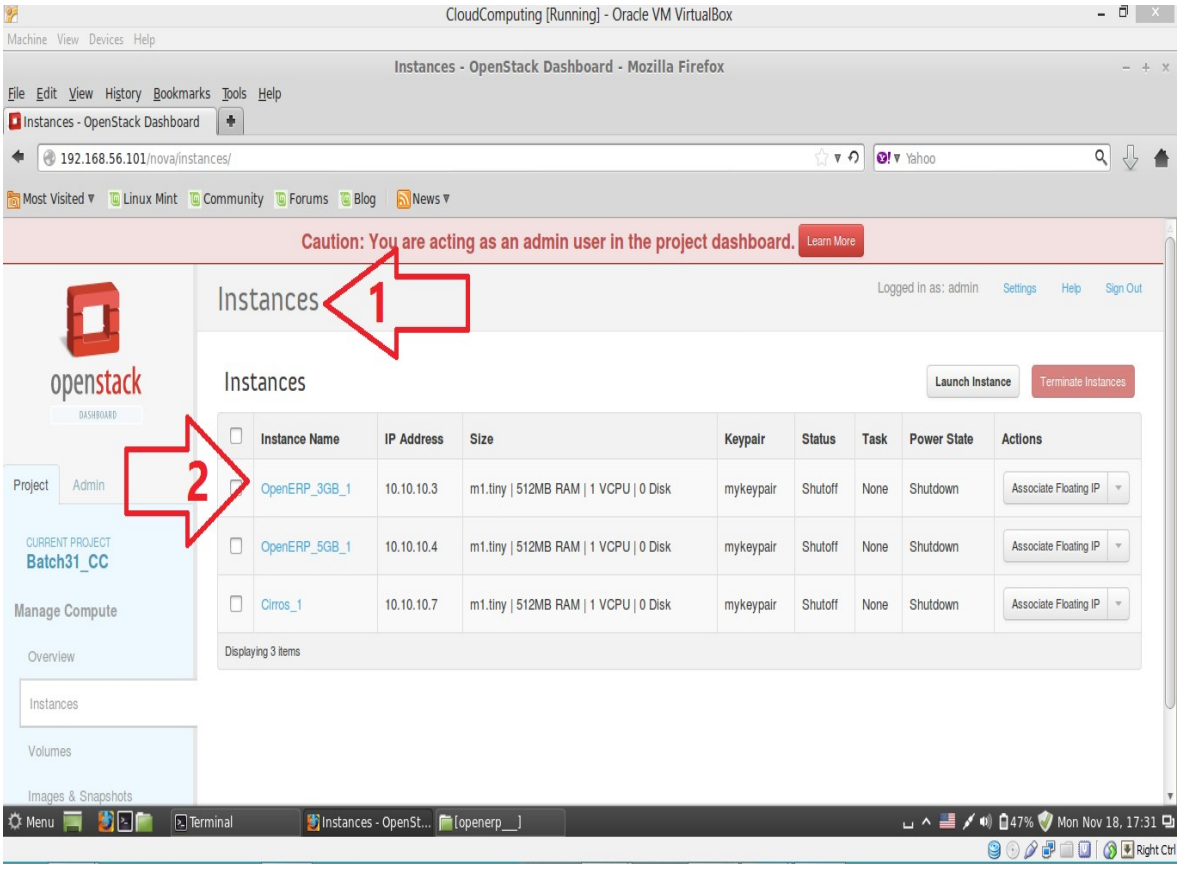


Figure D.12 images and snapshot interface.

Figure D.12 describes images and snapshot interface which is consist of all images that `upload and stored in open stack system so it denoted the sources of services that introduced through this system in this thesis.

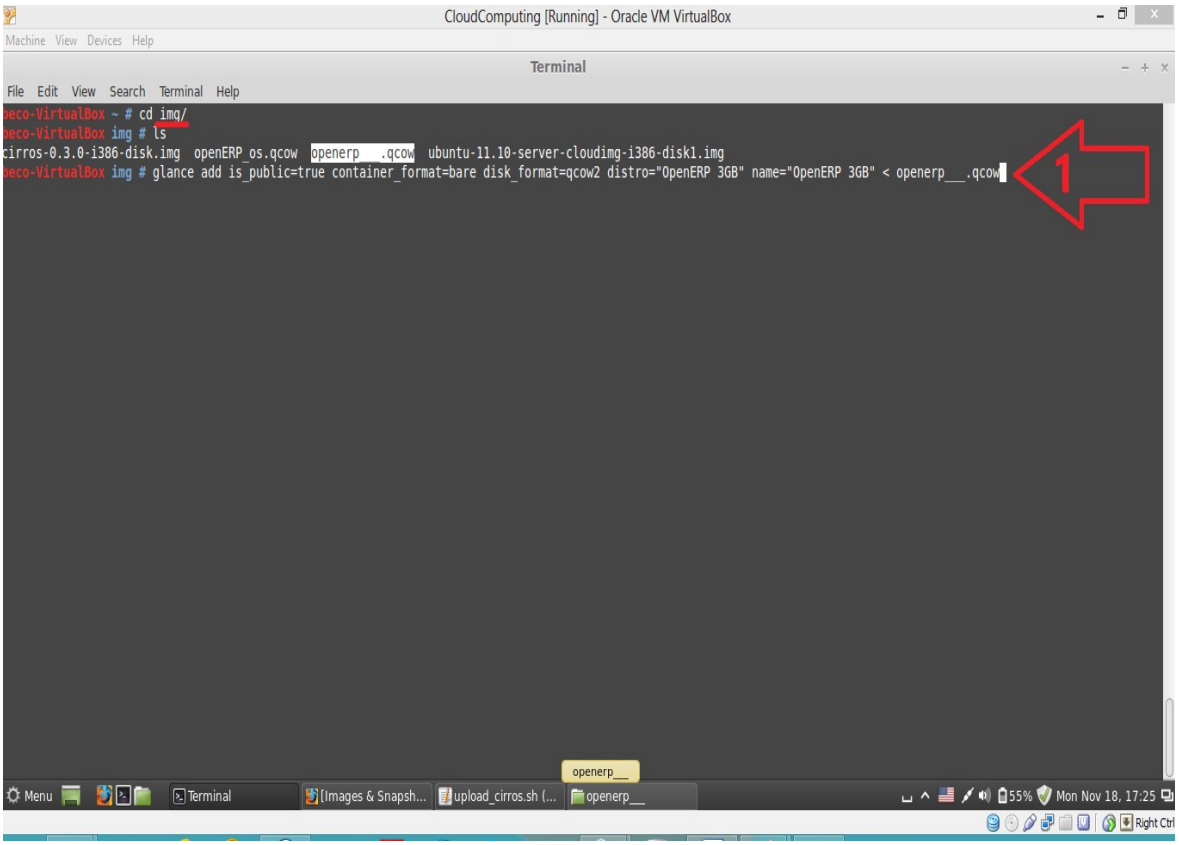


Figure D.13 shows the command use to upload images in open stack.

To upload images in this thesis it required at open stack to:

- Tied that images which include specific service we want to use through open stack system in one of syntax that open stack supported it like .img , qcow.
- Make new folder has name img use this command: **mkdir img**
- Enter to the new **img** folder copy and paste images that we want to upload it in system.
- Upload required mages to open stack system use the command

  Glance add is_public=true container _format=true

  Disk_format=qcow2distro=” **Referral System** 3GB”name=” **Referral System** 3GB” > **Referral System** ____.qcow

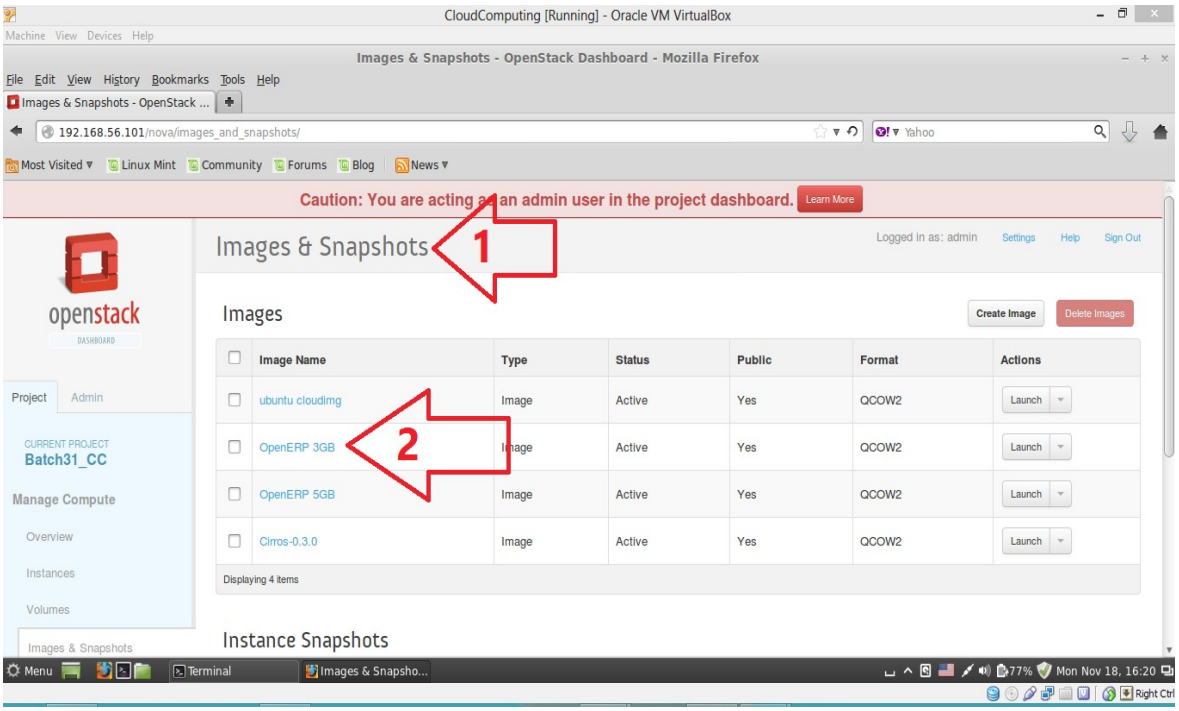
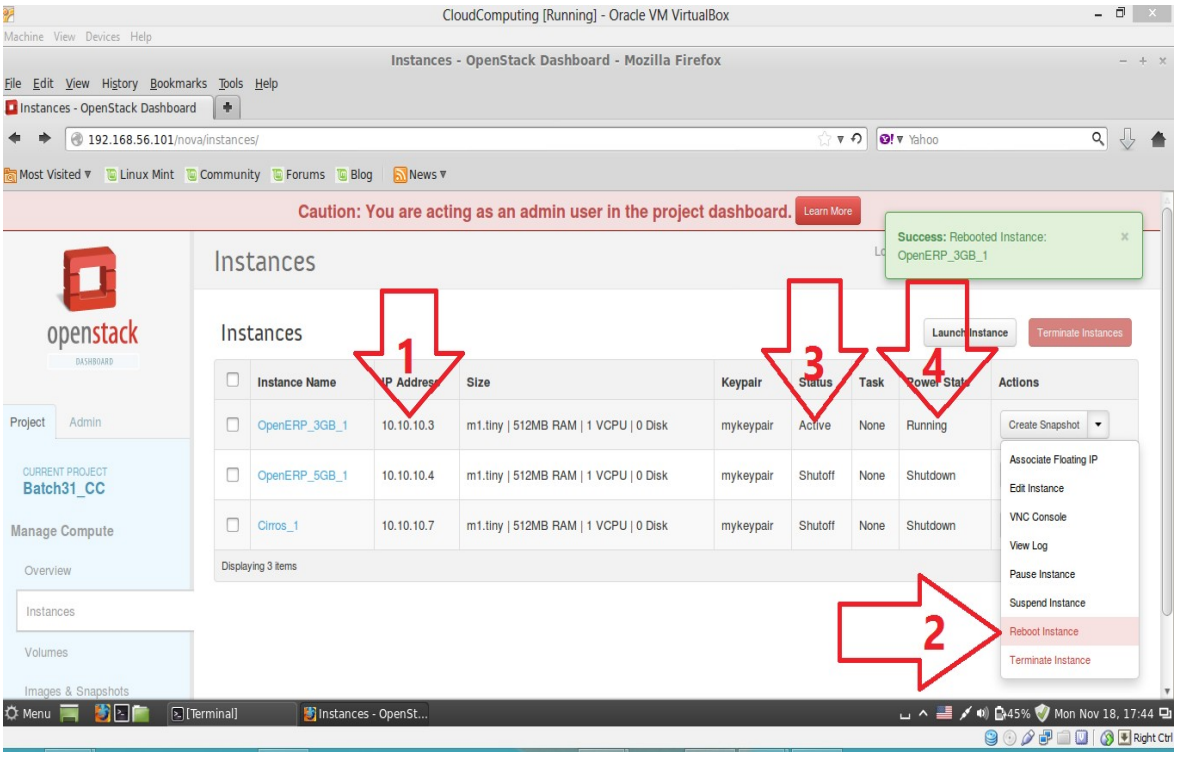


Figure D.14 instances interface.

Instances interface it a copy presented service to end users according to the demand and each service has ip, this ip give to every require service ,so there are three type of basic information represent to end user that is :

1. Ip for specific service.
2. User name for this require service.
3. Password for authentication for this service.



FigureD.15 operation of instances

Figure D.15 describes the operation of instances include creation, deletion, start and restart.

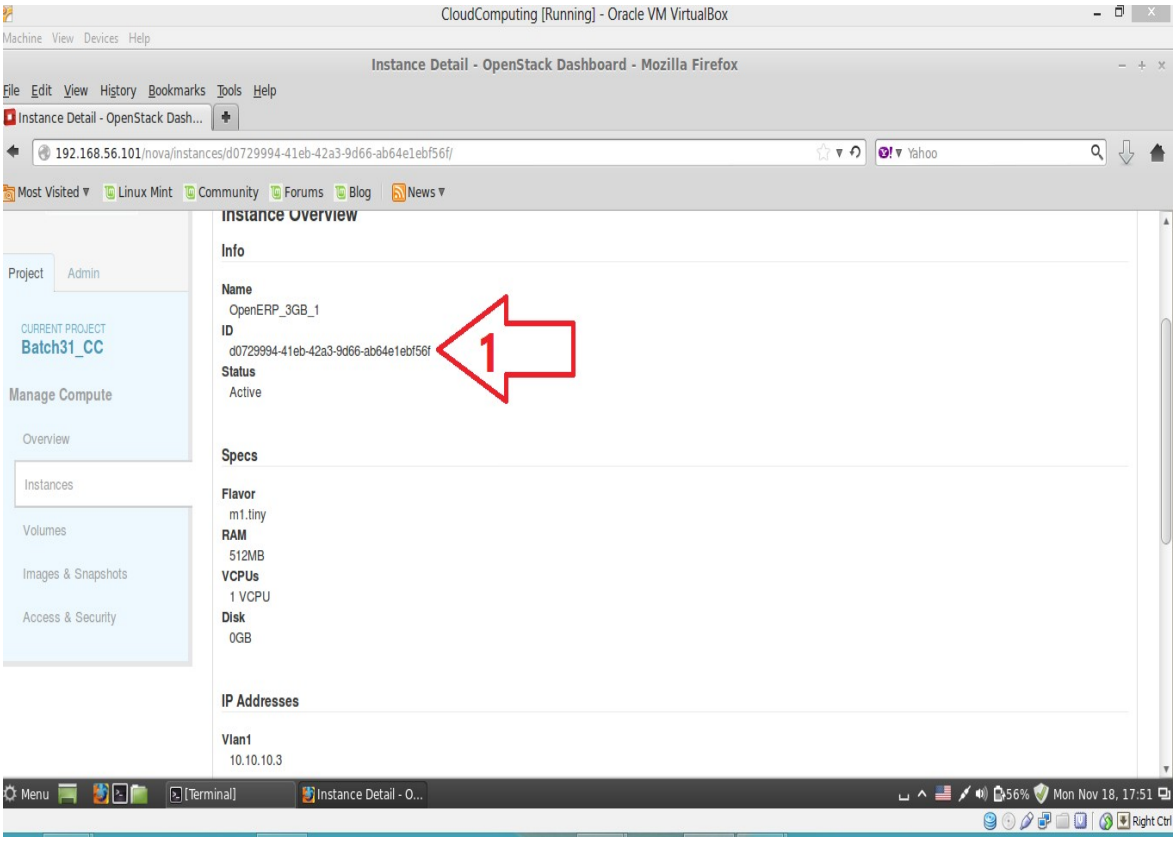


Figure D.16 instances IDs.

Figure D.16 describes instances IDs which is use operation at instances that not available at interface like control in status.
Open stack system provides ability to operate and test the instances on it before represent to end users through virtual network controller (VNC) interface.

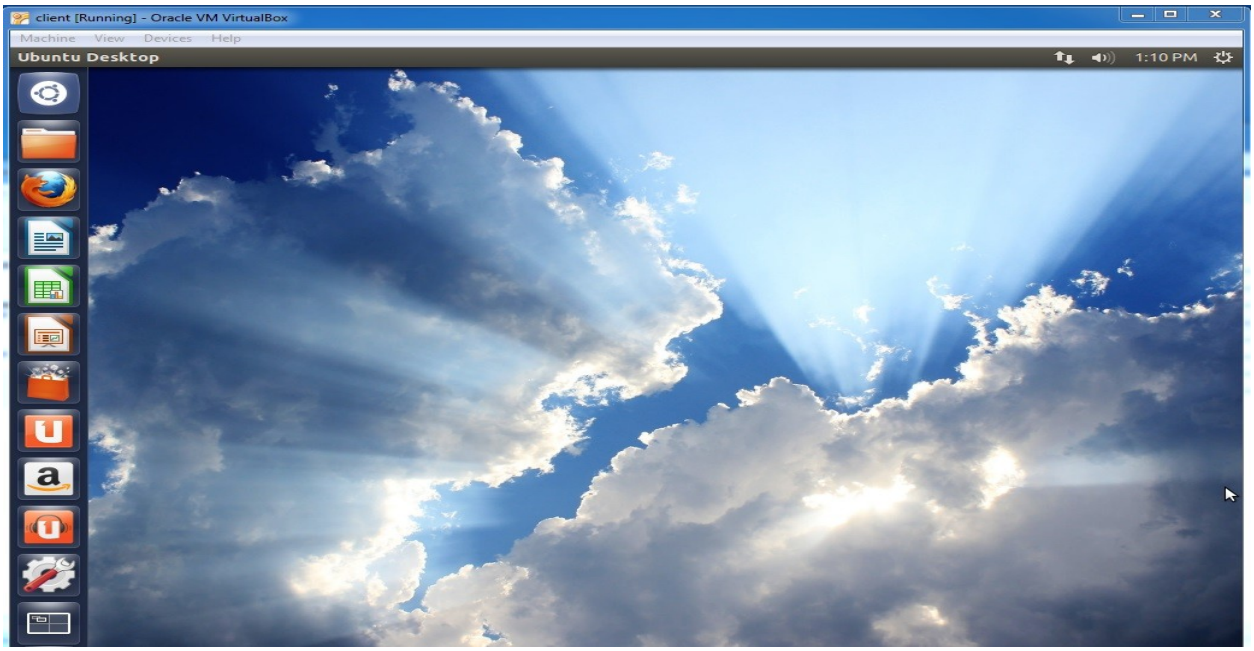


Figure D.17 VNC interface.

Figure D.17 show the login of user from client through **VNC interface**