

A Cloud Computing Framework for Adama City Government Sectors



Muktar Jeylan Seid

**A Thesis Submitted to the Department of Computer Science and Engineering
School of Electrical Engineering and Computing**

**Presented in Partial Fulfillment for the Degree of Master of Science in
Computer Science and Engineering**

**Office of Graduate Studies
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**June 2022
Adama, Ethiopia**

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Declaration

I hereby declare that this Master's Thesis entitled "A CLOUD COMPUTING FRAMEWORK FOR ADAMA CITY GOVERNMENT SECTORS" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

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List of Acronyms and Abbreviations

ACGS	Adama City Government Sector
ACGSHC	Adama City Government Sectors Hybrid Cloud
ICT	ICT Information and communication technology
IT	Information Technology
CC	Cloud computing
EC2	Elastic Compute Cloud
EBS	Elastic Block Service
S3	Amazon's Simple Storage Solution
IaaS	Infrastructure as a Service
PaaS	Platform as a Service
SaaS	Software as a Service
CRM	Customer Relationship Management
EthERNet	Ethiopian Education and Research Network
DSRM	Design Science Research Methodology
VM	Virtual Machine
SLA	Service Level Agreement
NIST	National Institute of Standards and Technology
VPN	Virtual Private Network
SOA	Service Oriented Architecture
RA	Reference Architecture
RM	Reference Model
SMT	Multi-Tenancy stack
VDI	Virtual desk-top infrastructure
CCRA	Cloud Computing Reference Architecture
TAM	Technology Acceptance Model
TOE	Technology Organization Environment

OCA	Open Nebula Cloud API
CC	Cluster Controller
SC	Storage Controller
NC	Node Controller
NASA	National Aeronautics and Space Administration
QoS	Quality of Service
OCCI	Open Cloud Computing Interface
XML	Extensible Markup Language
KVM	Kernel-based Virtual Machine
QEMU	Quick Emulator (Emulates a full system)
UML	Unified Modeling Language
OVF	Open Virtualization Format
Op-ex	Operating expenses
Cap-ex	Capital expenditures
WSDL	Stands for Web Services Description Language
SOAP	Simple Object Access Protocol
UDDI	Universal Description, Discovery, and Integration
EICTDA	Ethiopian ICT Development Agency
MCIT	Ministry of Communication and Information Technology
SDPRP	Sustainable Development and Poverty Reduction Program
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
RPC	Remote Procedure Calls
RCE	Resource Constrained Environment

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Abstract

Nowadays in Ethiopia, there are expansions of ICT infrastructure and services. These technologies are used to access and communicate information and also it closely linked to the economic growth of the country. However, the significance of Information and Communication Technologies (ICT) to the growth of government sectors service were not given the required level of attention in Addama. Due to this, the adoption of the latest information technology by government sectors in Adama is below the expected level. This research has examined and attempted to address the problem surrounding the low level of adoption and usage of latest information technology in the government sector in Adama, Ethiopia. Thus, this study was to propose a solution for the problem of low level of utilization of the latest information technology based service through cloud computing technology. The aim of the study was to develop cloud computing framework for Adama City Government Sectors.

This research work used the Design Science Research Methodology (DSRM), which is often used to address IT and organizational problems. It also utilized data collected through interviews conducted face-to-face with Government Sector managers and other stake holders that used basic ICT for their service operations in Adama city. The study applied comparative qualitative analysis techniques. Thus, this study indicated that the Adama Government Sectors have low knowledge to adopt this new technology.

The research identified and conclude that cloud computing is the better latest information technology utilization mechanism for Adama City Government Sectors. This is because first it enhances the service and effectiveness of certain activities or functions made by sectors. Second, it enables the wise and strategic use of information technology which significantly reduced cost. Accordingly, the research proposed the implementation of Hybrid Cloud computing model for Adama City Government Sectors. It expected that the adoption of this model will provide significant contribution to the economic growth of the city. The research further recommended in-depth analysis on multiple dimensions of adopting cloud computing to Government sectors beyond cost effectiveness and facilitation of their business operation. It also recommended additional study on security architecture of virtual data centers in cloud environment for these Sectors.

Keywords: Adama City Government sector, Information and communication technology, Cloud Computing

CHAPTER 1

INTRODUCTION

In recent years, there was a speedy improvement of computing offerings; computing sources became less expensive and more effective by using applying diverse records technology, among which Cloud Computing has been usually accustomed update the ordinary standalone device. The equipment of Cloud Computing has more and more come to be the priority of assorted sectors, both in evolved and growing nations; for that reason, researchers of the field are supplying their work by using discussing factors just like the demanding situations, blessings, and risks of the adoption and deployment of Cloud Computing.

Nevertheless, a studies hole exists inside the subject, in particular for a commonly agreed and commonplace theoretical framework for Cloud Computing for facilitating offerings in Government Sectors. In keeping with a theoretical framework; a shape or scaffolding for you to assist studies and deliver a guidance foundation which include an interrelated and coherent set of explanatory ideas, offering studies impetus to their definitions and meanings and current theories. A framework throughout this thesis is taken under consideration a way of providing applicable additives and their dating within Cloud Computing.

1.1 Background of the study

Adama City is found in the central part of Ethiopia. The 2015 Ethiopian census estimated its population at approximately 400,000 people. Nowadays, Government sectors in Adama are observing for ways to reinforce their competitive position and improve their service by adoption of new technology [1]. One of the main evolutions of the time that could provide the means for such competitive environment to facilitate business operation is ICT. So that ICT is a key driver of business strategy if survival and growth are critical to the service [2]. This research has tried to conduct, particularly the function of ICT in Ethiopia developing cities, particularly in Adama. The findings of this study showed that the government sectors are on a very low position of using ICT due to many reasons, among those are low in infrastructure development and employee in the area coupled with barriers from government policy. In general, the previous studies indicated that the challenges of ICT utilization and implementation in most Government sectors in developing cities are related either to financial issues, low infrastructure, legal issues or low IT knowledge [3]. Adoption and use of appropriate technologies can lead organizations to greater business competency, improve its

service performance, ensure and keep its competitive advantages. One of the appropriate technologies is cloud computing that affords organizations the opportunity to access on-demand IT services using Internet technologies on free or pay-per-use basis, thus enabling them to improve their strategic and technological agility and responsiveness in the global business environment [4]. Hence, it reduces the investment, operation and maintenance costs.

Around fifteen years lower back, the government of the Federal Democratic Republic of Ethiopia followed many techniques in order to boost up improvement. One amongst those strategies was the empowerment of local governments at Woreda/District degree via a technique known as decentralized [5]. With this imaginative and prescient, an initial authorities attempt became the implementation in 2003 of a government community called WoredaNet. The community became geared closer to being a critical region and connectivity network platform for the delivery of shared Information and Communication Technology (ICT) assets, with some selected services (video conferencing, email and Web hosting offerings) for facilitating the ordinary work activities, and permitting on hand and green community access for the ones shared resources (e.g. networks, servers, garage, and applications). The WoredaNet continued to supply services over the last decade. Some efforts are made to modernize the infrastructure and services and host more Web portals to supply data to citizens notwithstanding the truth that the bulk of those Web portals are static in nature.

However, with rapidly converting global technology, specifically Web and Internet-based, a growing need for dynamic and continuous access to sources exists among citizens, especially for reliable and well timed records approximately government, availability of online forms to be full of personal and other statistics, and access to transactional Web and Internet-based programs. Additionally, widely available mobile technology like clever phones have enabled citizens to certainly get right of entry to international records and advantage a knowledge of the technology reputе and records and repair availability in other countries, together with advanced economies.

As a result, get right of entry to statistics and technology has grown to be a challenging problem for governments of growing economies. It's going to require full-size investments within the modernization of the backend infrastructure to facilitate service delivery and understand the supply of well-timed and dependable information to citizens. The investment value of current information and generation — like the adoption, deployment, management,

and preservation of present day and up to date records and conversation technology — is for this reason broadly claimed as a heavy mission by means of Ethiopia and lots of other developing economies.

The adoption and implementation of Cloud Computing can also be one beneficial alternative for addressing the funding challenge, in addition as other demanding situations that governments face in turning in powerful and efficient authority's offerings to their citizens. More these days, authors claimed that government cloud-based totally service shipping has delivered undeniable advantages, particularly in lots of developed countries, and has emerge as important in growing economies for the facilitation of eGovernment offerings thru the adoption and deployment of Cloud Computing as gear to boost paintings activities and restore shipping.

However, without a normally prevalent standardized theoretical framework that can be followed according to the varied contexts of diverse governments, the exploration of troubles just like the function that Cloud Computing can play in fostering the shipping of eGovernment offerings to citizens, furthermore as identifying dangers and demanding situations in terms of protection, privacy, and data area, may also nevertheless undertaking the adoption and implementation of Cloud Computing generation.

For the capacity achievement of Cloud Computing in acquiring carrier provider by means of the developing economies and of the Ethiopian Government Network, it is for that reason becoming of giant challenge to have a framework for Cloud Computing which can easily be adopted and accessed to minimize risks.

1.2 Key Concept

1.2.1 Adama City Government Sectors (ACGS)

The term ACGS stands for Adama City Government Sectors. Adama is the second most populous city in Ethiopia and one of the fastest growing cities in the country. It is the largest city in the Oromia Region, which features industries and manufacturing enterprises, and is strategically located on the main road linking Addis Ababa to Djibouti. Adama city has 28 different government sectors which provide service for customers.

1.2.2 Information and Communication Technology (ICT)

ICT is defined because the era that defines clears the manner verbal exchange and assists in shooting, processing and transmitting IT [5]. During this study, Information and Communication Technology is

additionally taken into consideration due to the fact the software won't to serve essential business functions consisting of accounting and human sources' software program, client dating control (CRM) and offer chain control (SCM), inner IT utilization like Internet and email additionally as region resource making plans (SRP) that integrates all enterprise capabilities into one ADP machine.

According to [6], ICT offer exceptional technologies like computers, the internet, and websites also as fixed-line, cell phones and other wireless verbal exchange equipment, networks, broadband and diverse specialized devices.

1.3 Motivation

In developing countries, urbanization is an engine for growth and they play an important role in serving many people and ICT can be used as a tool [7]. However, like as many of the developing countries, the level of utilizing ICT in Ethiopian government sectors considered as low [4]. Since many of government sectors still operate using traditional-based approaches rather than adopting modern technologies.

Cloud computing, its services and deploying models, offers the opportunity for small businesses by subscribing to the pay-per-use method at an affordable price to access infrastructure, platform and software over the internet [8]. Therefore, in order to adopting cloud computing service in ACGS we may focus on their business process instead of on how to build, maintain, and manage their IT infrastructures.

Accordingly, forms of feasible demanding situations have been raised from this fame of WoredaNet and its technologies, which were idea to be constraining factors for the facilitation of nation offerings through Cloud Computing. WoredaNet is a Wide Area Network intended to link all woreda administrative units in Ethiopia. The technology presents unique opportunities to facilitate the application of e-Government packages in the country. "Woreda" is an administrative division in Ethiopia; which are composed of a number of Kebele. A WoredaNet is the Ethiopian government network; structurally it is a three-tier architecture (federal, regional and Woreda/district level) which is implemented by Ministry of Communication and Information Technology (MCIT) in collaboration with Ethio-Telecom and regional local governments.

Hence, it really became vital to conduct studies at the difficulty, explore and study present frameworks and presently available technological opportunities, to produce a framework for Cloud Computing which will facilitate Government offerings and cope with the challenges that an RCE may also pose.

1.4 Statement of the Problem

Documents of the Ministry of Capacity Building (MOCB) and also the Ethiopian Information and Communication Technology Development Agency (EICTDA) advocate that the WoredaNet may be aggregate of human beings and era (social-technical in information device) that constitutes the Ethiopian authority's network that grow to be carried out for the goal of transforming the government. It comprises diverse statistics facilities carried out in 11 regions at nearby and centralized degree, that are considered as effective tools of remodeling offerings in Ethiopia's public area through attempting to interchange the standard paper-primarily based machine with a green online carrier shipping to residents in various development sectors, consisting of agriculture, fitness, and training.

In this regard, a researcher for the duration of this domain, who pursuits to concentrate on improving and services, is likewise required to behavior an evaluation of the various perceptions of individuals, in times in which the making use of a applicable and appropriate theoretical framework of Cloud Computing can substantially help to grasp and interpret the effectiveness and efficiency of eGovernment offerings in Adama City to the very last public. This will be possible through a lens of the appropriate theoretical framework that may be used for the analysis of the meant contributions of Cloud Computing, likewise because the viable dangers and challenges inside eGovernment services in terms of fostering provider transport.

Adama Government institution is also displaying effective motivation to leverage current infrastructure and offerings in pleasurable its readiness to undertake Cloud Computing and to boost provider shipping to citizens; this component is diagnosed via this thesis due to the fact the real motivation for discovering the sphere of interest.

Ethiopia ICT sector has seen substantial growth over the last decade [9]. This technology is used to access and communicate information and closely linked to the economic growth of the country. Consequently, according to [10], in Ethiopia different initiatives are working as part of a national capacity building program that includes National Data Center, Regional Data Center, WoredaNet, School Net, Ethernet, AgriNet that aims to provide connectivity and specialized applications for schools and for local governments.

All organizations in today's world should adopt the latest information technology to be competitive for sustainability and growth. However, adoption of the latest information technology by Government Sector in Adama City is low. This means the activity to adopt

latest technology is not observed as in developed country. According to FMI (file management interface) one of the main reasons for slower technology adoption is simply because many firms aren't aware of the solutions that are available to them. That is understandably so, given the number of point solutions that have been developed in recent years. Another reason for slower adoption is that the construction industry has been waiting for the tech world to catch up. The construction industry is often tasked with building custom buildings and factories, for unique clients and products, sometimes hundreds of miles away from civilization. In some cases, these projects represent the most difficult and complex problems that need to be solved. To fully digitize construction, contractors have had to wait for the input, which means that design the framework needs to be digitized. This has happened, to a degree, with the advent of building information modeling.

Consequently, they are not competitive in the globe and rarely to improve their service. Additionally, in traditional IT environments, increasing the complex management issue of software, hardware and networking equipment require specialist staff for implementing and maintaining IT services. Such problems that mention in the above need close attention. In summary, the following constraints identified from previous research work in existing conditions of ICT in Ethiopia on Government Sectors [11]: These are;

- ❖ Lack of reliable and cost-effective IT infrastructure
- ❖ Inability to identify Government Sector and Service they provide

Thus, these situations give more motivation for commencing to propose a framework for adopting latest Information Technology (IT) through cloud computing technologies. These are based on the Government Sectors Service requirements in the context of Adama, Ethiopia. So that the proposed a framework for cloud adoption from the perspective of cloud-based service delivery architecture considered. Defining a robust and scalable architecture is key to the success of cloud computing implementations, because of it provides a means of communication and coordination between the cloud service providers and the users [12].

To address the problem for the above mentioned, the following research questions were formulated and answered with the result obtained at the end of the study.

1. How can traditional IT help for Adama Government Sectors in the current situation of their Service operation?
2. Are the current ICT infrastructure and service delivery strategy are efficient for Government Sectors in Adama?

3. How a Government Sectors can choose the most suitable option for any specific application or service to gain benefits into latest information technology particularly cloud computing?

1.5 Objectives of the Study

1.5.1 General Objective

The general objective of the study is to develop cloud computing framework for Adama city Government Sectors.

1.5.2 Specific Objectives

In order to achieve the general objective, the following specific objectives are identified.

- ❖ To examine the current ICT usage and practice in Adama, Ethiopia Government Sectors.
- ❖ To develop cloud-based service delivery architecture that can provide cloud service for Adama City Government Sectors.
- ❖ Explore and identify challenges that the resource-constrained environment (RCE) can pose for Cloud Computing for facilitating eGovernment services.

1.6 Significance of the Study

This research work outlined the challenging issues faced the utilization of latest information in Government Sectors that found in Adama, Ethiopia. The paper proposes cloud computing framework to efficiently utilize the potential of cloud computing as latest information technology to add value for Government Sectors. Therefore, the significance of this study is to enable Government Sectors on adoption and usage of cloud computing service. Additionally, the study could be used as a baseline for further studies of the latest information technology utilization strategy to be considered in different governmental organizations in Ethiopia.

1.7 Scope and Limitation of the Research

1.7.1 Scope

Most Government Sectors usually do not have adequate funds to acquire latest information technology but, there are a service process that performed by Government Sectors which can be replaced with a cloud-based service to get a cheaper and a more effective way of doing a particular on their service operations in Adama, Ethiopia. There are many types of cloud solutions available to service today. Hybrid clouds provide the best of both public and private cloud computing models.

Therefore, aim to deal in this study was only related to cloud services on making the adoption and usage as simple as possible by the Government Sectors that found in Adama, Ethiopia, so that the users can easily migrate to cloud-based services without facing any difficult issues and this framework encourage and accelerate the adoption of cloud computing among the sectors. The outcomes demonstrated that avoiding the capital expenditure and cost.

1.7.2 Limitation

This study's main limitation was that the information used for the results especially on the recommended framework was derived from the data obtained from the major Government sector that were already aware about cloud-based services, this was due to the limitation of cost and time. This study was limited to a number of selected Government Sectors. This study's main limitation was that the information used for the results especially on the recommended framework was derived from the data obtained from the major Government sector that were already aware about cloud-based services, this was due to the limitation of cost and time. This study was limited to a number of selected Government Sectors. Although a framework for Cloud Computing in RCEs to facilitate eGovernment services in the Adama context was provided, this thesis recognizes that there were limitations to the study, which require further research on the topic of interest. The limitations of the study in identifying all the components of a Cloud Computing framework in RCEs to facilitate eGovernment services in the Adama context are acknowledged. The suggestions made by this thesis are for the provision of possible future research to reach a fully developed and worldwide-accepted theoretical framework that was not achieved; this requires further research.

1.8 Organization of the Thesis

This thesis consists of five chapters. In the following, we highlight the contributions the remaining chapters of this thesis. The organizations of the papers are as follows: -

Chapter Two: -Conceptual Discussions and Review of Related Literature this chapter explores general, but necessary knowledge of cloud computing including the definitions and related technology. And also consists of key issues of relevant literature regarding of cloud computing adoption strategy on Government Sectors in developing countries.

Chapter Three: - Discussed and elaborated about ICT solution to Government Sectors in Ethiopia. This section aims to determine the level of ICT utilization amongst the Government Sectors that have been selected for the purpose of this research.

Chapter Four: - Proposed Cloud-Based Services for Adama City Government Sectors.

This section presented about the proposed a framework for cloud adoption that helps to efficiently utilize the potential of cloud computing as the latest information technology solution to add value for Government Sector service.

Chapter Five: - Demonstration and Evaluation, and also Simulate the proposed framework and presents evaluation results, and a discussion about the results.

Chapter six: - Presents a summary of the main conclusions, limitations, and contributions of the thesis, and some proposals for the future work.

CHAPTER 2

LITERATURE REVIEW

This chapter explores the key issues in the related literature which are relevant to this research work as standards and influenced our work such as concept and necessary background knowledge about Cloud Computing. Finally, the study is review related work of the cloud computing adoption literature on City Government Sector Services in developing countries.

Several previously related literatures (books, articles and the Internet) are reviewed in order to have detail understanding on this research works. Different techniques and tools which are relevant for the current research are analyzed, modified and used from previous works.

2.1 Overview of Cloud Computing

This section provides a popular review of Cloud Computing; which includes its definitions, characteristics, Cloud models, Clouds structure and advantages moreover because the key technology on which Cloud Computing depend.

Loosely talking, Cloud Computing can be a shape of computing paradigm inside which normally actual time scalable resources like documents, records, packages, hardware, and 1/3 party services will be on hand from an internet browser thru the net to customers. These customers pay just for the used computer sources and offerings via customized Service Level Agreement (SLA), having no expertise of the way a carrier provider makes use of an underlying laptop technological infrastructure to aid them. The provider load in Cloud Computing is dynamically changed upon end-users' carrier requests [17].

2.1.1 Definition

There is no universally common definition. However, there was much discussion in the enterprise on what cloud computing honestly manner. In September 2011, the National Institute of Standards and Technology (NIST) described cloud computing as [18]. This may be a broadly usual definition of cloud computing:

“Cloud computing could be a version for permitting ubiquitous, handy, on-demand community get right of entry to resources (e.g. Networks, servers, storage, applications, and offerings) that may be unexpectedly provisioned and launched with minimal management effort or service provider interaction”

The cloud is a combination of hardware and software, storage, services and interfaces that facilitate the provision of information as a service. There are many actors and participants in the world of the cloud. The stakeholders in cloud computing includes: the vendors or suppliers: providing the applications and facilitating the corresponding technology, infrastructure, platforms and information; the suppliers' partners: these create services for the cloud, offering services to clients; business leaders: assess cloud services for implementation in their organizations and companies; and end users, who use cloud services, whether for free or on payment of a fee.

Hybrid cloud refers to a mixed computing, storage, and services environment made up of on-premises infrastructure, private cloud services, and a public cloud—such as Amazon Web Services (AWS) or Microsoft Azure—with orchestration among the various platforms. Using a combination of public clouds, on-premises computing, and private clouds in your data center means that you have a hybrid cloud infrastructure.

The primary benefit of a hybrid cloud is agility. The need to adapt and change direction quickly is a core principle of a digital business. Your sectors might want (or need) to combine public clouds, private clouds, and on-premises resources to gain the agility it needs for a competitive advantage. Not everything belongs in a public cloud, which is why so many forward-thinking companies are choosing a hybrid mixture of cloud services. Hybrid clouds offer the benefits of both public and private clouds and take advantage of existing architecture in a data center.

The hybrid approach allows applications and components to interoperate across boundaries (for example, cloud versus on-premises), between cloud instances, and even between architectures (for example, traditional versus modern digital). The same level of distribution and access flexibility is also needed for data. Whether you're handling workloads or datasets, in the dynamic digital world, you should plan for things to move around in response to evolving needs. Where applications or data live today might not be the best place for them to live over time.

Hybrid cloud scenarios

- ❖ **Dynamic or frequently changing workloads.** Use an easily scalable public cloud for your dynamic workloads, while leaving less volatile or more sensitive, workloads to a private cloud or on-premises data center.

- ❖ **Separating critical workloads from less-sensitive workloads.** You might store sensitive financial or customer information on your private cloud, and use a public cloud to run the rest of your enterprise applications.
- ❖ **Big data processing.** It's unlikely that you process big data continuously at a near-constant volume. Instead, you could run some of your big data analytics using highly scalable public cloud resources, while also using a private cloud to ensure data security and keep sensitive big data behind your firewall.
- ❖ **Moving to the cloud incrementally, at your own pace.** Put some of your workloads on a public cloud or on a small-scale private cloud. See what works for your enterprise, and continue expanding your cloud presence as needed—on public clouds, private clouds, or a mixture of the two.
- ❖ **Temporary processing capacity needs.** A hybrid cloud lets you allocate public cloud resources for short-term projects, at a lower cost than if you used your own data center's IT infrastructure. That way, you don't overinvest in equipment you'll need only temporarily.
- ❖ **Flexibility for the future.** No matter how well you plan to meet today's needs, unless you have a crystal ball, you won't know how your needs might change next month or next year. A hybrid cloud approach lets you match your actual data management requirements to the public cloud, private cloud, or on-premises resources that are best able to handle them.
- ❖ **Best of both worlds.** Unless you have clear-cut needs fulfilled by only a public cloud solution or only a private cloud solution, why limit your options? Choose a hybrid cloud approach, and you can tap the advantages of both worlds simultaneously.

2.1.2 The Characteristics of Cloud Computing

NIST argues that the cloud model has five fundamental characteristics, three service models, and four deployment models. As shown in figure 3.

The main characteristics are [18]

- ❖ **On-call for self-service:** The capacity for a stop person to sign up and get hold of services without the long delays which have characterized traditional IT.
- ❖ **Broad network get right of entry to:** Ability to get right of entry to the provider through trendy systems. (Desktop, computer, cell).
- ❖ **Resource pooling:** Resources are pooled throughout more than one clients.
- ❖ **Rapid elasticity:** Capability can scale to address demand peaks.

- ❖ **Measured carrier:** Billing is metered and added as a software provider.

2.1.3 Cloud Computing Models

NIST classifies cloud computing models into two main categories [18].

- ❖ **Deployment models.** This refers to the position (location) and administration (management) of the cloud infrastructure (Public, Private, Community, Hybrid)
- ❖ **Service models.** This refers to specific services that can be accessed in a cloud computing (Software, Platform, and Infrastructure as Services).

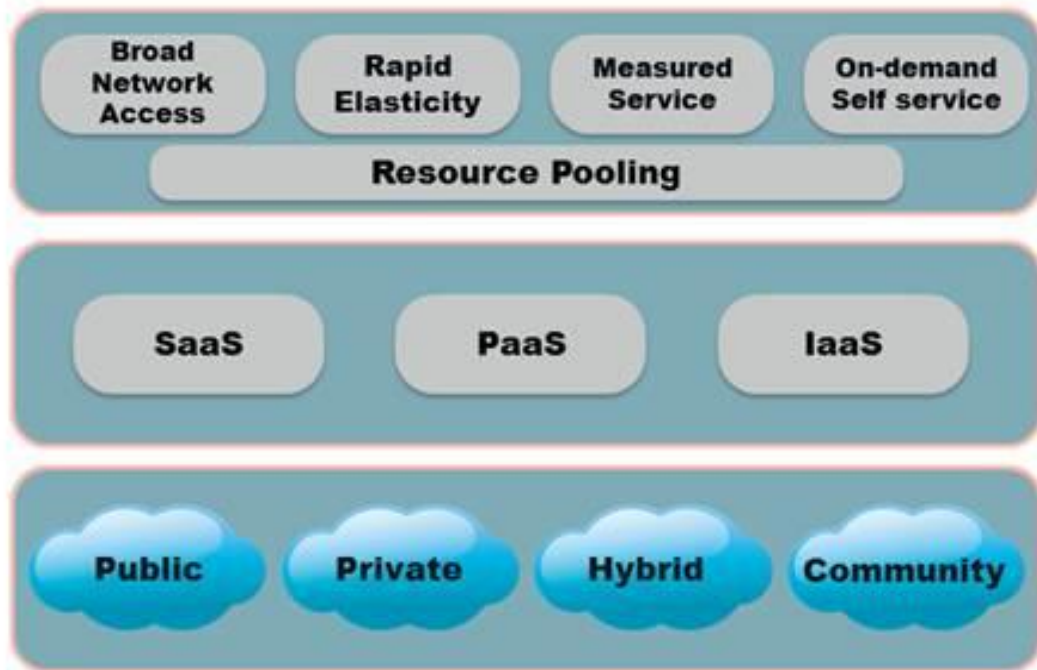


Figure 1: Cloud Computing Model [18]

2.2 Security Issues in Adopting Cloud Computing

Currently, cloud computing technology has brought the idea of storing and managing data on virtualized servers so that, applications, individuals, and organizations around the world can have the ability to connect to data and computing resources anywhere and anytime. Therefore, this means that cloud computing needs to request to the feelings of the clients and address the potential security risks in a manner that clients will feel safe and secure. By addressing security in this way clients will feel safer and secure, hence trust cloud service providers. Clients must demand transparency, avoiding vendors that refuse to provide detailed information on security programs. Therefore, an important risk factor in cloud computing in security and privacy According to [19] data security and privacy are the two major security concerns for the organizations to adopt cloud services.

Most cloud security problems arise because of lack of control, lack of trust mechanisms etc. These problems exist mainly in third party management models and also self-managed cloud platforms. Security is very difficult to implement in cloud computing because of the different forms of attacks in both the application side and in the hardware components.

According to [20] identification, there are seven security issues that need to be addressed before Government Sectors consider switching to the cloud computing model. They are as follows:

1. **Privileged user get admission to:** Information transmitted from the patron through the Internet poses a certain diploma of threat, due to problems of data ownership; firms have to spend time studying their companies and their guidelines as a whole lot as viable earlier than assigning some trivial packages first to check the water.
2. **Regulatory compliance:** Clients are answerable for the security in their solution, as they are able to pick out between vendors that allow being audited by way of 0.33 birthday celebration corporations that test degrees of security and carriers that don't.
3. **Data location:** Depending on contracts, some customers might in no way recognize what us of a or what manipulate their statistics is located.
4. **Data segregation:** Encrypted data from multiple businesses may be saved at the same difficult disk, so a mechanism to separate statistics has to be deployed by way of the issuer.
5. **Recovery:** Every provider has to have a catastrophe recuperation protocol to shield user facts.
6. **Investigative help:** If a customer suspect's fault activity from the provider, it cannot have many prison ways pursue an investigation.
7. **Long-term viability:** Refers to the capacity to retract a settlement and all data if the cutting-edge issuer is offered out by using another firm.

2.3 Cloud Computing Reference Architectures, Models and Frameworks

This section reviewed different cloud architectures and reference framework for cloud computing.

Usually, a reference framework for cloud computing attempts to provide the baseline that stands on designing some interoperable cloud services and additionally their integration inside the current infrastructures of the Internet and cloud provider vendors. On a normal foundation, a reference framework ought to provide a draft or an architectural template that would be used by others that wish to undertake comparable answers. A reference version is composed in explaining the principles and relationships which sustain reference structure,

whilst the time period reference framework refers to both Reference Architecture (RA) and Reference Model (RM) [21].

2.3.1 Reference Architecture (RA)

Cloud structure defines as a comprehensive set of talents that may help the transport and management of various types of cloud services in a unified provider control surroundings, and facilitate the shipping of these services in a hybrid surroundings [22] as proven in parent 4 below.

According to [21] classify Cloud reference architectures as one of two styles:

1. **Role-based:** Where activities or capabilities are mapped to roles such as cloud provider or consumer.
2. **Layer-based:** Where activities or capabilities are mapped to layers in architecture such as application or resource layers or to the service management architecture or security architecture.

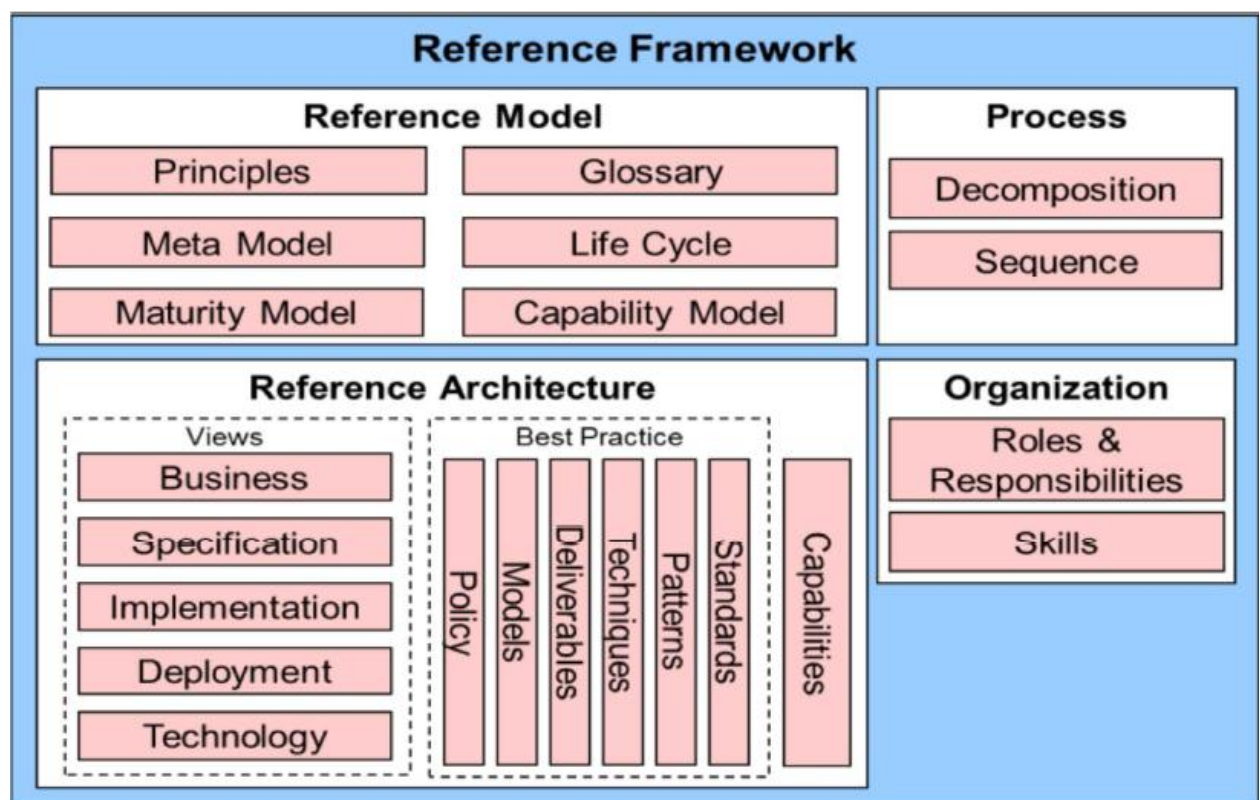


Figure 2: Generalized reference framework [21]

According to [23] the RA presents a technical blueprint for a device with a well-defined scope, the requirements it satisfies, and the architectural decisions it realizes. It guarantees

consistency and nice throughout development and shipping initiatives. Next, we can present 3 of the most crucial reference architectures inside the subject:

- ❖ Reference architecture CISCO - Cisco Cloud Reference Architecture Framework [24]
- ❖ Reference architecture IBM – IBM CCRA [25]
- ❖ Reference architecture -National Institute of Standards and Technology (NIST) [26]

Cisco Cloud Reference Architecture Framework

The CISCO reference architecture is based totally at the cloud definition provided by means of NIST. In Figure four shows that some of the fundamental factors of growing in the cloud which consist of the general steps of virtualization, integration, automation and subsequently cloud service offerings. After presenting these fashionable steps Cisco suggests the Cisco cloud method for Government Sectors which incorporate 3 essential points [24]

- ❖ It offers services, and solutions for Government Sectors to build a secure cloud
- ❖ It allows Government Sectors to supply secure cloud solutions and services to internal clients
- ❖ It contributes to the cloud marketplace by promoting innovative technologies, open source standards and ecosystems development.

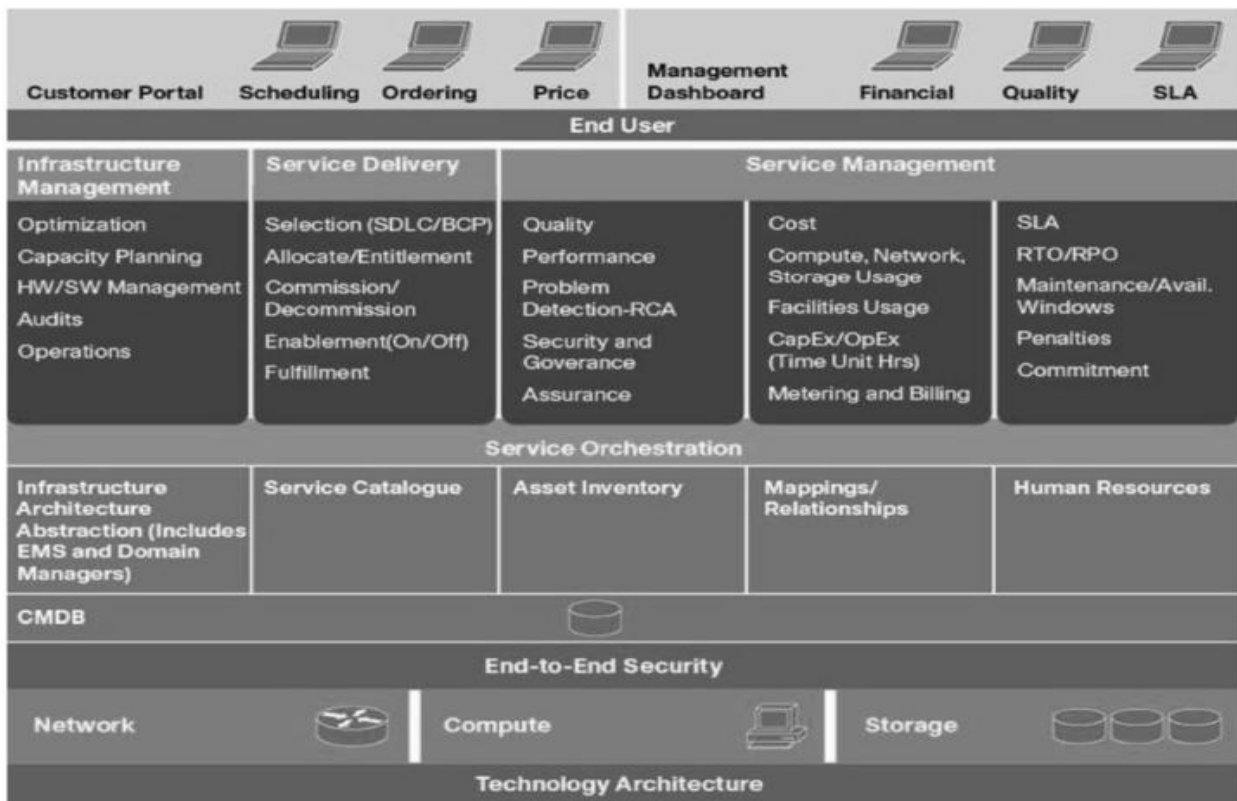


Figure 3: Cisco's cloud computing reference architecture [24]

IBM Reference Architecture

The proposed reference architecture from IBM is called IBM CCRA (Cloud Computing Reference Architecture). IBM CCRA [25] is reflected in the design of IBM's cloud, developing for clients, hosting services and in IBM's products with a focus on reducing costs and obtaining a high rate of security, reliability, scalability and control.

The last version, IBM CCRA 3.0, offers a series of new benefits, these are:

- ❖ Prescriptive guidance for designing IaaS, PaaS, SaaS solutions by using IBM's products.
- ❖ Consists of various architectural products which represent the best options in IT industry in regard of designing, implementing and administration roles and permissions in the cloud for consumers, service providers and builders of cloud services.
- ❖ Represents a modular framework which allows focusing on the most important field for cloud development (IaaS, PaaS, SaaS, and CSP).

It offers a comparative sketch with the scope of realizing an analysis of the clients of the cloud with the goal of identifying integration points.

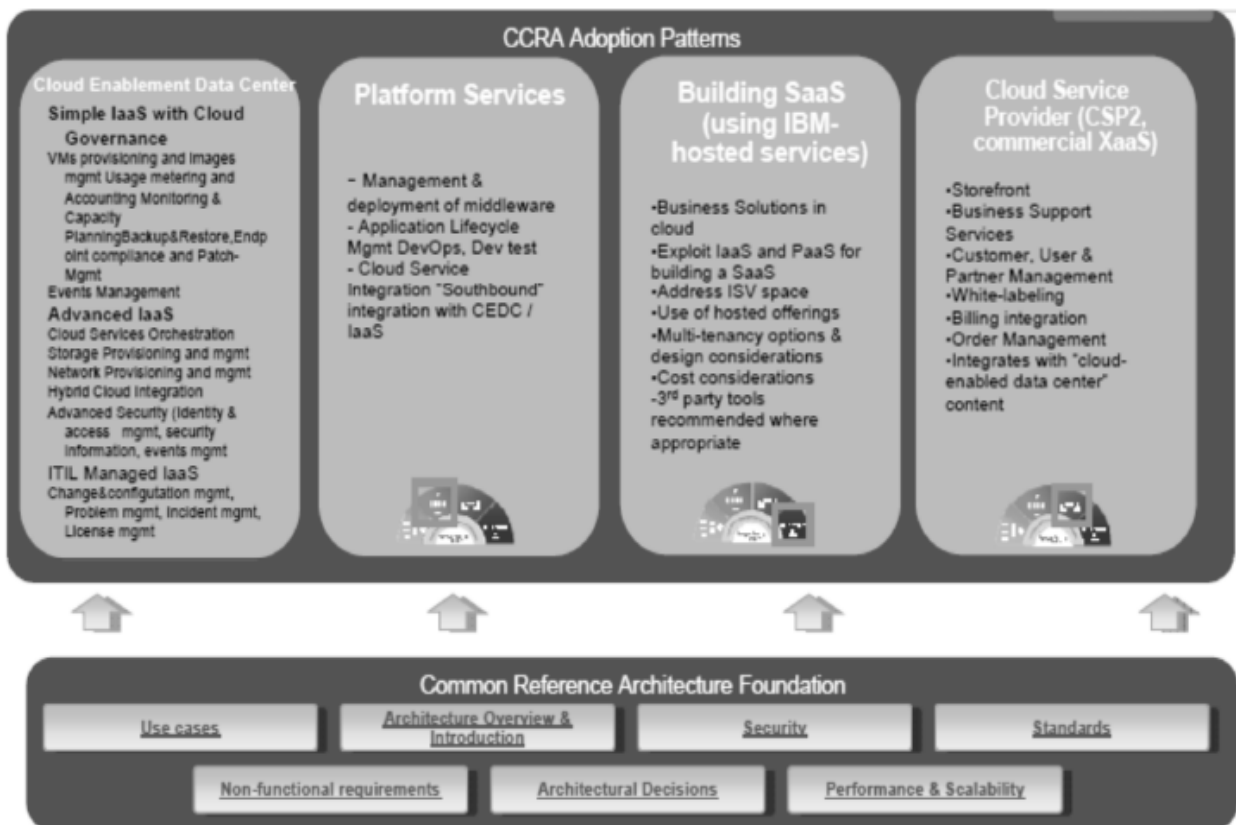


Figure 4: A model for adopting IBM CCRA [25]

In Figure 6 we can see the proposed model for adopting IBM CCRA 3.0, based on four models which contain:

NIST Reference Architecture

National Institute of Standards and Technology (NIST) [26] - NIST's reference architecture is a high-level conceptual generic model that represents a powerful tool when it comes to talking about requirements, structures, and operation in cloud computing.

The design of the NIST reference architecture serves the following objectives:

- ❖ Understanding and illustration of various services of the cloud in the context of a generalized conceptual model for cloud computing.
- ❖ Providing technical references to governmental agencies and to other consumers for understanding, analyzing, categorizing and comparing cloud services.
- ❖ Security communication and analysis, possible standards for interoperability and portability and reference implementations.

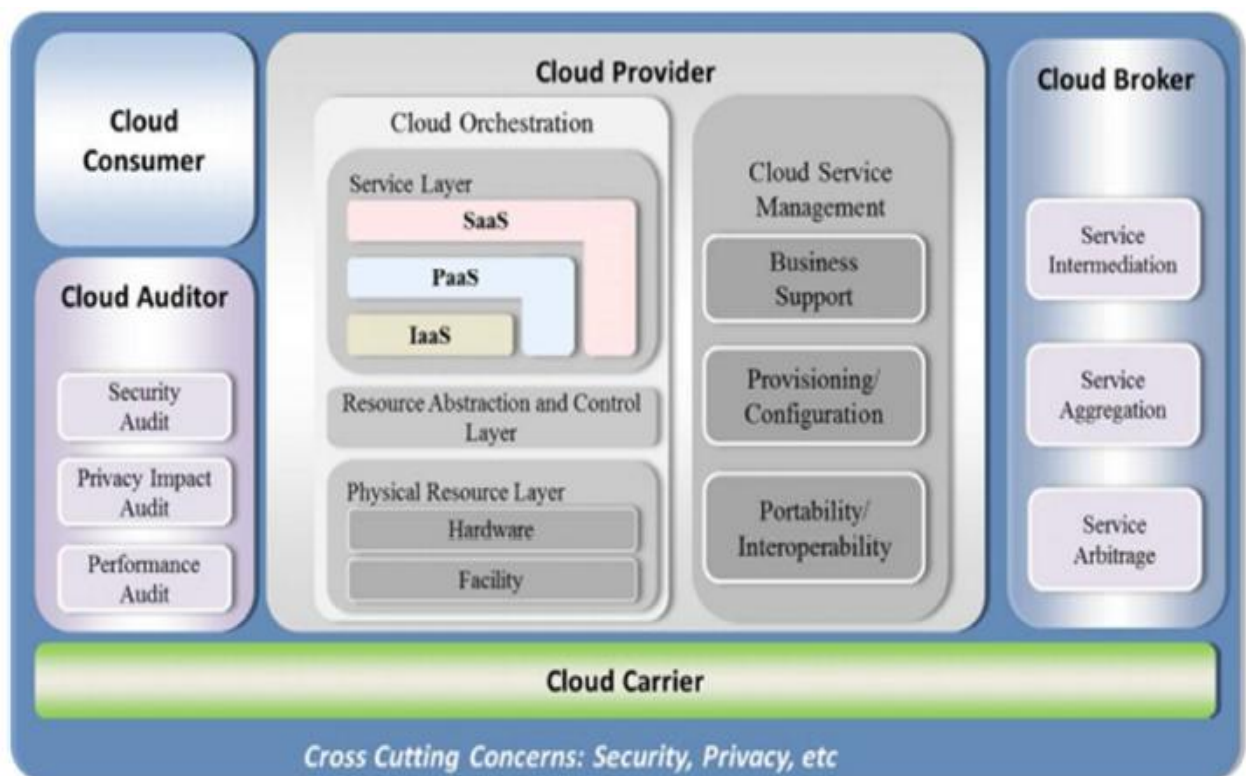


Figure 5: The NIST conceptual reference model [26]

The NIST cloud computing reference architecture proven in above Figure 6, defines 5 most important actors: cloud purchaser, cloud provider, cloud service, cloud auditor, and cloud broker. Each actor is an entity (someone or a sectors) that participates in a transaction or procedure and/or performs duties in cloud computing.

- ❖ **Cloud Consumer:** A person or organization that maintains a business relationship with, and uses service from, Cloud providers.
- ❖ **Cloud Provider:** A person, organization, or entity responsible for making a service available to interested parties.
- ❖ **Cloud Auditor:** A party that can conduct an independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
- ❖ **Cloud Broker:** An entity that manages the use, performance, and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.
- ❖ **Cloud Carrier.** An intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

Table 1: Comparison between cloud architectures

Model	Comparison Business level	Comparison on Architecture level	Key Difference
IBM	For general cloud computing system	Defines a layered model which considers resources, security, service, and consumer layer.	The only layered Architecture
Cisco	Especially for enterprise cloud	Defines a management framework for enterprise clouds, which focuses on management of diff. components And lifecycles.	Compared to IBM, considers the only cloud Management
NIST	For general cloud computing system	Defines actors (cloud computing consumer/ provider / carrier/auditor/ broker).	Refers to the composition of system components to support the Cloud Providers activities

As a shown inside the above table, the cloud structure wishes to aid the basic necessities of any cloud solution, which include:

- ❖ **Delivering cloud services:** wherein packages, facts, and IT sources are swiftly provisioned and furnished as a standardized providing to users over the internet in a bendy pricing model.
- ❖ **Managing cloud services:** wherein large numbers of noticeably virtualized resources are controlled such that, from a control angle, they resemble a unmarried huge useful resource. These sources may be controlled in one of this way to facilitate speedy elasticity dependent on the demands for the cloud offerings.

Basically, the complete cloud computing gadget can be divided into the core stack and the management [26] all the layers offer external provider thru internet service or other open interfaces. In the core stack, there are three layers:

1. **Resource** The aid layer is the infrastructure layer which is composed of bodily and virtualized computing, storage and networking resources.
2. **Platform** The platform layer is the most complex component which might be divided into many sub-layers; e.g. A computing framework manages the transaction dispatching and/or undertaking scheduling. A garage sub-layer provides unlimited garage and caching functionality.
3. **Application** The application server and other components assist the equal standard utility good judgment as earlier than with both on-demand capability or bendy management, such that no additives might be the bottleneck of the entire machine

2.4 The Current Status of ICT in Ethiopia

ICT has turn out to be an integral part of Ethiopia's improvement packages over the past decade, following initial indifference to the improvement of the world. The use faces a huge gap among hobby within the ICTs and the coverage and regulatory devices to be had to permit its development. ICT is one of the most crucial components of the Sustainable Development and Poverty Reduction Program (SDPRP) of the Ethiopian authorities. The maximum consolidated and modern coverage framework is the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) that runs among 2005 and 2010. Five important duties had been designed in regards to the ICT location improvement within the PASDEP report [27].

- ❖ Promoting human useful resource improvement inside the ICT area;
- ❖ Mainstreaming using ICT in all sectors of the economy, inside the administration of presidency, and in the training device;
- ❖ Developing the necessary telecommunications infrastructure;
- ❖ Promoting research and improvement via ICT; and
- ❖ Creating allowing felony and regulatory framework.

The arrival of Information Communication Technology (ICT) as a major factor in economic growth means that more developing countries like Ethiopia will pursue policies that open up their country to mobile, the internet, and broadband penetration. The three key areas of mobile, internet and broadband will be critical to the spread of the cloud computing services. With cloud computing, economic growth can be encouraged through the cost reduction in

hardware and software that businesses and governments must spend to run their information system.

The large ICT zone policy of the Ethiopian government that derives from PASDEP turned into evolved in 2006 by the Ethiopian ICT Development Agency (EICTDA). One of the important thing areas where the policy aims are: “Promote the use of ICT for modernizing the civil and public service to beautify its performance and effectiveness for provider delivery, to sell desirable governance and reduce wastage of scarce resources.

To achieve the above objectives, the Ethiopian Ministry of Communication and Information Technology (MCIT) has undertaken a number of e-Government initiatives to improve the internal efficiencies within the government organizations and to improve the access to government services for the general public. These initiatives are explained as follows [27].

The major initiatives can be divided into four major categories: - Infrastructure, the backbone of ICT activities, connectivity, and networking.

Infrastructure

Ethiopia has been constructing its fiber backbone. A country wide spine fanning out from the capital Addis Ababa in seven directions has been beneath production because of a large investment thru a supplier financing mortgage agreement with China's Zhongxing Telecom Corporation (ZTE). The 10,000km fiber community connects seventy-eight towns with a capability of STM-1 (i.e. hundred and fifty-five Mb/s), 46 towns with a potential of two.5 GB/s and 9 cities with a potential of 10 GB/s. In addition, National Data Center, Regional Data Center, WoredaNet, School Net, Ethernet, AgriNet are among major e-government projects that are upgraded following the construction of the National backbone [1]. The Status of ICT Infrastructure in Ethiopia as indicated as below table.

Table 2: Status on ICT infrastructure in Ethiopia

Services	Number of Users	Capacity in Five Years	User per 100 Inhabitants
Landline Telephone	1 Million	8.5 Million	10
Mobile	10 Million	40 Million	50
Internet Users	200,000	7.17 Million	8.5
Ruler Connectivity (In 5KM Radius in %)	49.3%	90%	-
Wireless Coverage of the Country	<50%	90%	-
International Link Gbps	3.2	20	-

2.5 Review of Related Work

This section describes the literature on first-class practices of cloud-primarily based service implementations and framework development works for cloud-primarily based service adoption approach in the area.

2.5.1 Need for Cloud Computing for Adama City Government Sectors

According to [28] compared to developed city, the get admission to ACGS in the direction of human and economic assets is low. Therefore, they do no longer have the potential to effectively use and improve their IT systems with the intention to meet changing sector necessities efficaciously. Cloud computing gives the right approach to those IT problems with the aid of presenting scalable competencies and infrastructure to ACGS. Therefore, ACGS which might be working with small IT departments can rent IT services instead of purchase them by using making use of their constrained assets. They have additionally diagnosed some other benefits of cloud offerings, for example, green use of the computing system, low level of hardware funding, and quicker improvements of software.

Moreover, the literature suggests that cloud computing adoption by way of ACGS shows that the sectors are prompted to apply cloud computing services thru the net as a way to decorate their service abilities. The changing nature of cloud computing makes it highly suitable for ACGS and also proposed two business models for companies which are willing to adopt cloud computing services – business models for companies with existing IT infrastructure and business models for startup companies [29]. Cloud computing provide a diversity of needs of computing resource for users and organizations. For many organizations, the advantages to adopting cloud computing are increasingly attractive as it can add capacities quickly to an IT system without investing in new expensive infrastructure, buying new software, or training new personnel [30].

One of the attractive and important cost issues in the cloud computing is the capability to pay for service based on needs and avoiding the large expenses for computer systems buys [31].

2.5.2 The Existing Cloud Adoption Frameworks

Cloud Computing is helping sectors to address issues of cost, efficiency, flexibility, and scalability among others. From the quest on Google scholar, there are 3 articles selected that aim to manual and help the selection makers in deciding on and implementing a cloud answer. All of these articles are published after 2010, indicating that the subjects surrounding

the cloud strategy are still surprisingly an infant compared to the implementation strategies of other IT structures. These areas have been fairly covered within previous literature review.

A purpose-orientated necessities engineering approach for cloud adoption via [32] the objective of this approach is to assist the customers in screening, matching, and negotiating their necessities in the direction of the cloud service's provision and also to manage the tradeoffs concerning the matches and mismatches of the requirements. The methods of this requirement engineering for cloud may be visible in Figure 8 and are described because the followings.

1. **Acquire and specify desires.** The aim is described as a target that must be completed via the device. There are 3 categorizations for goal definition: 1) the strategic dreams – concerned with the survival of enterprise, 2) excessive level or center dreams – are the principle motivations to undertake a cloud answer, and three) operational dreams – are the more precise necessities together with the password protection, encryption mechanism, and many others. These goals will then be prioritized by using the important thing stakeholders.
2. **Assess the functions of cloud provider issuer.** This is whilst the look for capability cloud companies is began. Several issues in this phase are the full price possession in opposition to the finances, the cloud company's reputation, and whether the cloud answer satisfies the predicted desire-.
3. **Perform matching.** The matching technique entails the statistics collecting and analysis to take a look at whether the cloud services meet the dreams. The cloud provider may be considered as first-rate if the glad desires are inside the appropriate variety.
4. **Analyze mismatches and manipulate dangers.** The mismatch among desires and cloud services is carefully analyzed to explore the tradeoffs and manipulate the risks. A chance management is necessary to help in figuring out and handling the dangers previous to their conversion to threats.

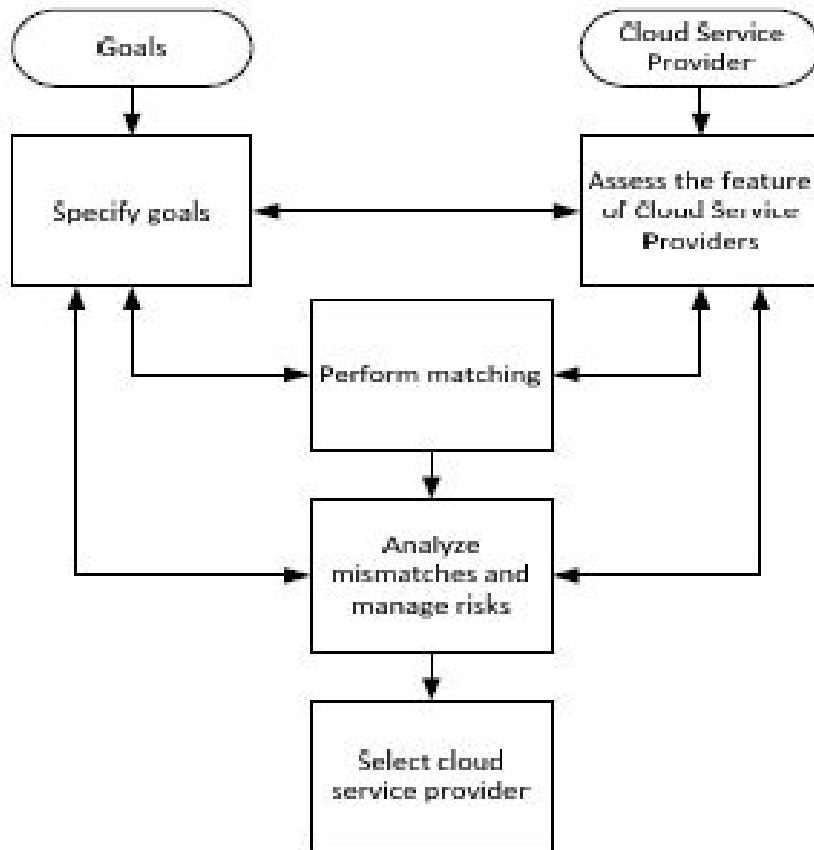


Figure 6: Cloud adoption approach by Zardani and Bahsoon [32]

Cloud adoption toolkit via [33] a conceptual framework for organizing the selection-making such as the supporting gear to do the evaluation is elaborated. There are five predominant steps inside this framework, as proven in Figure eight.

1. **Technology suitability analysis.** This segment is to make sure that the technical suit of cloud services guides the favored technological traits. A simple tick list is defined for this evaluation and consists of the subsequent characteristics: the preferred elasticity, communications, processing, accessibility, availability, protection necessities, facts confidentiality, and regulatory requirements.
2. **Cost modeling and energy consumption evaluation.** This phase helps the choice making with the accurate estimation of the costs and power consumption associated with using cloud computing. The output of this phase may also guide the machine architects in designing the appropriate IT infrastructure in time period of the operational prices and energy intake.
3. **Stakeholder impact analysis.** This is to assess the organizational healthy whether or not the impacted company can cope with the capacity influences caused by the cloud offerings in time period of practicalities (time, sources, abilities), social factors

(values, pleasure, reputé), and political elements (fairness of gain distribution, risks, and so on.).

4. **Responsibility modeling.** This is ready the evaluation of operational feasibilities by way of the use of growing a set of responsibilities and mapping them with the sports to realize the nonfunctional characteristics of the device. This is likewise to pick out and determine the strategic dependencies among organizations.
5. **Requirements and implementation.** Requirements and implementation. This is whilst the real implementation takes region. Cloud adoption method via [34]. This method carries six tiers of adoption lifecycle, beginning from the preliminary phase until the governance of non-stop operations.

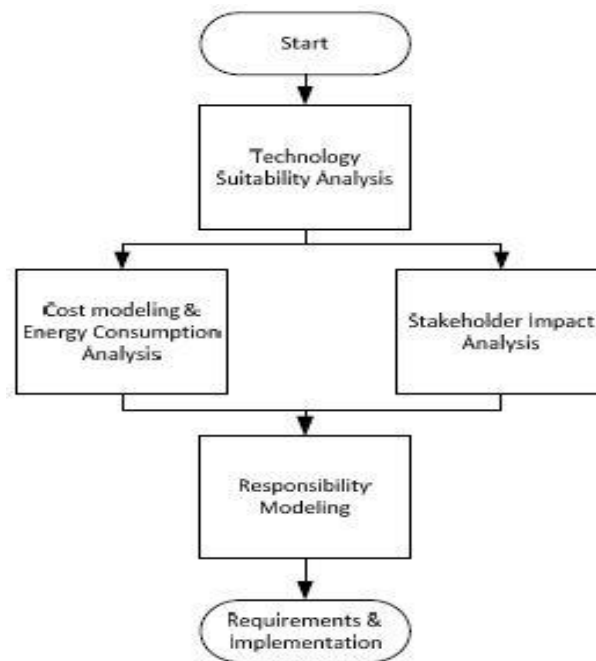


Figure 7: Cloud adoption toolkit by khajeh-hosseini [33]

1. **Initial planning:** In this section, a excessive-level evaluation exploring the business goals and how adopting a cloud can healthy with the commercial enterprise approach is performed. There are several key outputs from this phase, i.e. The business version wherein the modern abilities and values are explored to find the necessary enhancements, a excessive-degree plan of tasks inclusive of the assignment proprietors, and the predicted business outcomes to be realized in a due time.
2. **Sector talents and cloud vision:** The cognizance of this segment is to provide an know-how of the overarching talents had to assist the cloud implementation. Several key paintings artifacts from this segment are the vision declaration of cloud adoption; adoption pattern; a commercial enterprise case which affords statistics about possible

charges and blessings, value propositions and ROI for the cloud; and a governance version.

3. **Target architecture and cloud enablers.** In this section, the necessities influencing the cloud adoption choices are explored in greater information. There are 3 areas applicable for the updates in the present EA in relation to the cloud adoption: 1) the enterprise architecture, 2) the facts device, and 3) generation and infrastructure structure.
4. **Gap evaluation and transition making plans:** Gap evaluation is necessary to help the assessment of agency's actual performance with its potentials and thus to know the shortfalls of the contemporary scenario. A transition plan is a instruction for a change and for this, a sufficient know-how of the exchange management needs is vital to reaching the advantages. The key deliverables for this segment are a alternate control plan which addresses the way to arrange the people and the organization from its modern us of a to the future nation, and a cloud adoption roadmap which offers a list of actions for understanding the cloud adoption technique.
5. **Implementation making plans:** This is the final phase of cloud adoption method in which an association with the cloud issuer is made and the settlement is signed to start the vital works. The key sports activities of this section are the SLA arrangement and the additives of the mixing necessities.
6. **Governance.** This is a non-prevent pastime which underlines the entire methods of cloud adoption. The governance is anticipated to offer a strategic route which defines how the cloud adoption may be achieved, managed and controlled.

2.6 Conceptual Framework

This section is provided and facilitates knowledge accumulation and creation about the frame work for cloud computing adoption for ACGS. Its purpose is to develop the conceptual framework and related hypothesis based on the previous literature. This study will propose a framework of cloud computing adoption strategy by developing a theoretical framework.

2.6.1 Adoption of Cloud Services and its Challenges

Cloud adoption is a strategic move by organizations of reducing cost, mitigating risk and achieving scalability of IT resources capabilities. Cloud adoption may be up to various degrees in an organization, depending on the depth of adoption. For instance, a survey conducted by [35] revealed that organizational perceived benefits such as accessibility,

scalability, cost effectiveness, and security can influence the decision on cloud computing adoption. [29] Found that the capacity of IT resource, resources usage, data privacy, and the scope of business activity could also affect the adoption of cloud computing in firms.

The researchers are investigating adoption challenges in clouds, such as Service Level Agreements (SLA) [36] business models and classification [37]. SLA focuses on billing models and has direct implications on prices. Business fashions and classifications tend to attention on the manner groups can reap the profitability no longer constrained to SLA. A limitation approximately SLA is that they best attention on operational tiers and aren't immediately connected to strategic stages. Other aspects of a hit cloud delivery ought to be investigated at a much broader scale, especially the alignment among the strategic and operational awareness of cloud adoption. To assist groups designing, deploying and supporting clouds, specifically personal clouds, thinking about both strategic and operational methods for cloud adoption is suggested. [31]

Describe cloud computing technical adoption demanding situations and considered carriers' lock-in, records privacy, safety and interoperability because the maximum vital demanding situations. [38] Identify human social troubles in cloud adoption to be resolved and provide an explanation for their significance the use of case research. This approach adoption challenges want to take technical, monetary and organizational problems into strategic attention earlier than adoption and implementation take region.

2.6.2 Influential Factors of Cloud Computing Adoption Theories

The reason of this section is to check associated literature for identify the maximum common and used variables which might be related to the adoption of cloud computing services by ACGS. Prior literature has investigated some of influential factors in the adoption of cloud computing that can be classified into three kinds, the technological factors, organizational factors, and environment elements.

The following are researchers that focus on cloud computing adoption using different adoption theories.

[39] Employed generation acceptance version to find the element that affects the adoption of purchasers to cloud computing. Findings of the quantitative observe confirmed that perceived usefulness, perceived ease of use, company kind, and security has a strong affiliation with the adoption of cloud computing.

According to [40] TOE framework recall technological, organizational, and environmental elements with associated sub-elements in developing an ACGS cloud computing adoption model this is theoretically grounded at the technology– sector–surroundings framework and discovered that these three elements have an impact on the adoption of cloud computing. [41] Used comparable method and employed TOE to discover the problem of the cloud. The findings showed that innovation feature has a strong have an effect on cloud computing adoption. Similarly, era context and organizational and environmental context have a sturdy influence at the adoption of cloud computing.

[42] It merged between TOE and TAM to look at the elements that have an effect on the cloud computing adoption. The findings confirmed that relative benefit, compatibility, complexity, organizational competency, schooling and training, top management support, usefulness, and simplicity of use are the factors that affect the adoption of cloud computing.

[43] It is viable to evaluate the factors influencing to ACGS to undertake cloud computing in developing economies. The study revealed that key factors like reduced cost for IT purchases and maintenance, improved communication internally and externally, scalability, business continuity and access to expertise are the key drivers for adoption and main barriers were lack of skill and knowledge, poor internet connectivity, security and data privacy, lack of trust and difficulty in integrating with in-house systems. Additionally, it was found that top management support, resistance to new technology, the presence of existing infrastructure and compatibility with cloud services, the competence of cloud provider and vendor support are the most influential organizational factors used in the adoption decisions.

Moreover, these theories also are briefly mentioned under the table below.

Table 3: Outer of cloud adoption studies

No.	Author	Objective	Methodology	Key Findings (factors)
1	Abdollahzadehgan, <i>et al.</i> , [44]	Evaluating organizational success factors for adopting cloud computing in SMEs.	Qualitative methodology was used to gather data and evaluate it under the TOE framework	Organizational factors ▪ Top management support ▪ Firm size ▪ Technical readiness
2	Morgan, Lorraine [45]	Exploring factors that affect adoption of cloud computing technologies	The qualitative interview was used to collect data and Analyzed using open coding and axial coding under the TOE framework.	<i>Technological</i> Liability, relative advantage, compatibility, complexity <i>Organizational</i> desire to improve collaboration and promote openness, increased

				traceability and audibility, losing control of IT environment <i>Environmental</i> Security and legal issues,
3	Seo, Kwang- Kyu [46]	Exploring Factors in IaaS cloud service adoption	Uses TAM framework	perceived security

In Summary, we conclude that the above-stated cloud computing adoption fashions are twofold:

1. Although various factors affect cloud computing adoption amongst previous researchers' findings, these kinds of factors may be categorized in technological, organizational, or environmental contexts. Thus, its miles feasible to use the generation-company environment (TOE) framework to explore the cloud computing adoption problem.
2. Most studies have explored the importance of the technological factors affecting cloud computing adoption. However, the affects of environmental and organizational factors on cloud computing adoption variety throughout distinct organisation contexts. Therefore, there can be a need to investigate the determinants of cloud computing adoption inside the one-of-a-type sectors to gather a better expertise of cloud computing adoption.

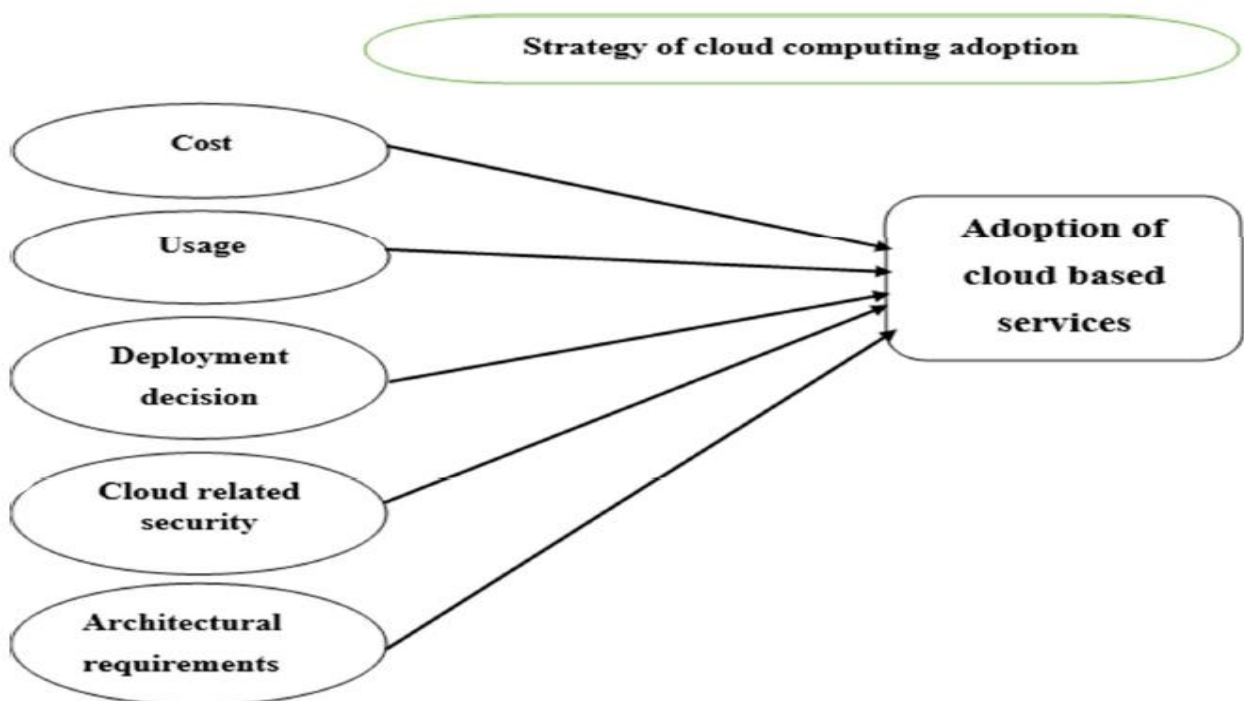


Figure 8: Shows the result conceptual framework

Figure 8 shows the ensuing conceptual framework that was used to perform the baseline observes on cloud computing for ACGS. The direction of arrows indicates a detail of causal impact. As shown within determine above the conceptual framework for this study consist of different elements:

CHAPTER 3

METHODOLOGY

3.1 Introduction

The role of ICT ranges from changing individual lives to controlling the step and path of the world economy. One of the reasons for this limitless coverage is the availability of ICT for almost every business and social activity. ICTs and ICT based services can be produced to serve a general purpose that crosses industries and business activities. On the other hand customized ICTs and its' services are what really make ICT the essence of every business organization. Successful IT program implementations among other things need holistic perspective, understanding of dynamic forces at play, the ability to project future consequences of actions taken today and managing the right alterations to get the desired results.

3.2 Overview of Research Methods

In order to develop the knowledge base about the current state of IT need, structure and usage in Adama Government Sectors, the study followed qualitative research approach. This method was selected because of one of the study aims was to explore about ICT utilization and challenge in Government Sectors, the current ICT infrastructure and service delivery strategy and finding an alternative solution from an operational point of view.

The population of this study does not include all Government Sectors in Adama due to limitation of resources such as time and money. The interviewed sectors were selected from research site for the following reasons: Adama is the second capital city of Ethiopia; also one of largest city in Ethiopia, Moreover Adama is considered the commercial and industrial center in Ethiopia. In Adama city the total number of government Sectors are 28 [44]

In the qualitative research stage, purposeful sampling focuses on selecting information-rich cases. It typically focuses in-depth on relatively small samples, even single cases, which have been purposefully selected. The samples for the present study are selected from Adama which include both Government Sectors that have successfully employed an IT system for their business operations and those that have faced problems. Another criterion when the sectors were selected was that they should basic ICT adopt at least one of the following areas of ICT: office packages (Word, Excel etc.), Internet searching and browsing, e-mail, or a Web site for their business activities.

$$n = \frac{\left(\frac{P[1-P]}{\frac{A^2}{Z^2} + \frac{P[1-P]}{N}} \right)}{R}$$

(Watson, 2001)

Where:

n: minimum sample size required-30

N: total number of people on the population-1027

P: estimated variance in population - 50%

A: precision desired – 23.18%

Z: Based on confidence level – 95%

R: Estimated response rate- 98%

Purposive sampling was used for data collection in this study, which means that the organizations are selected purposive form, because of according to the observation the number of organizations that aware about cloud based serves were small. So that the best suitable respondents were chosen, these were service from different government Sector that found Adama, Ethiopia. The number of Sector was obtained from the Adama City Administration Mayor Bureau that covers all of the six Sub Cities. The selected Sectors have better balanced distribution of main types of Sectors that are given higher priority. Therefore, the main reason to select these sectors; are the nature of the representativeness of their data.

Finally, after the collected statistics are analyzed and summarized for a better expertise of the IT utilization and utilization. The procedure followed on this observes was: the usage of the interview to accumulate information, describing the information and analyzed, it in comparison to applicable literature assessment then findings of the study.

3.3 Methodology of the Study

The research used qualitative research approach, due to its characteristics. So that in order to achieve the general and specific objectives of the study and answer the research questions, the study followed the research model based on well-accepted elements of the Design Science Research Methodology (DSRM) process [13]. The main purpose that we were select Design Science Research Methodology (DSRM) was; it is well-planned research design that helps to ensure that our methods match our research aims, that we collect high-quality

data, and that we use the right kind of analysis to answer our questions, utilizing credible sources. This allows us to draw valid, trustworthy conclusions.

The construction and evaluation of the designed artifacts follow a sequential order, illustrated in Figure 9. This process is iterative and is divided into five different steps, which are explained below.

1. **Problem identification and motivation:** Defines a specific research problem and justifies the value of a solution. Our research problem becomes that adoption of the latest information technology by Government Sectors in Adama is low. Consequently, they are not competitive in the globe and rarely to improve Service and performance of an organization. The following constraints identified from previous research work in existing conditions of ICT in Adama on Government Sectors [3]: These are
 - ❖ Lack of reliable and cost-effective IT infrastructure
 - ❖ Inability to identify Government Sector and Service they provide
2. **Objectives of a solution:** The objective of the solution helps to efficiently utilize the potential of cloud computing as the latest information technology, these are formulated and used as the direction and representation of the intended objectives of this research.
3. **Design and development:** It started with examined the collected as well as analyzed data. Also, concepts from various literatures such as cloud adoption strategy are reviewed and combined into a comprehensive workflow in order to lead adopt and use cloud computing in an enterprise. The proposed a framework was developed for adopting latest Information Technology (IT) through cloud computing technologies based on Government Sectors Service requirements in the context of Adama, Ethiopia.
4. **Demonstration:** Implementation details serve as a demonstration of the approach. The proposed framework could involve in the simulation to observe solution to the problem.
5. **Evaluation:** the evaluation we made interviews with practitioners, this will be obtained to develop further insights into the usefulness and weaknesses of this framework. Finally, thesis report.

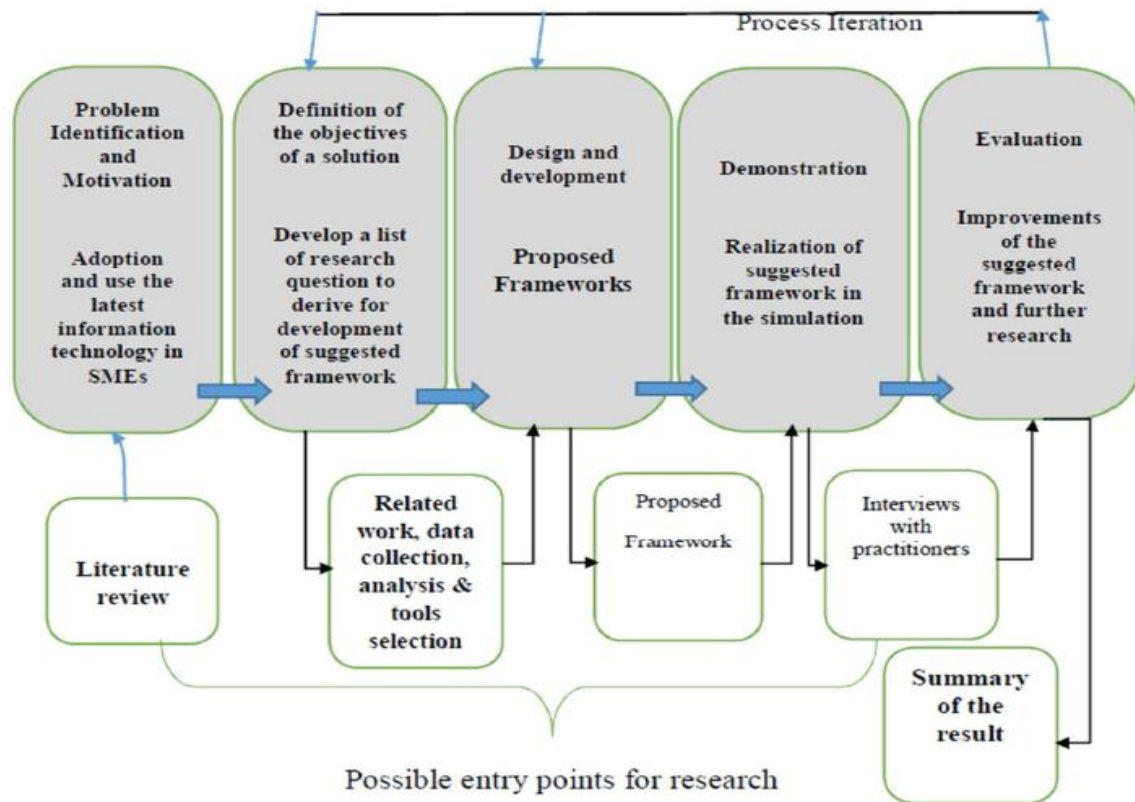


Figure 9: Research model based on DSRM process [13]

3.3.1 Data Collection and Analysis Method

Data Collection Method

This study consists of both primary and secondary data. The nature of the data that are required to conduct this research can only be collected through the qualitative methods. Since the qualitative data collection is the best option for this research work to collect the required data and information in order to draw the best results. The option of qualitative study for this research is the outcome of a mirroring on the nature of the difficulty. Eye to eye interview methods were favor to quantitative methods as they provide intricate details of the qualitative situation. In this study, semi-structured question was observed as the richer and most important way to collect data.

The qualitative data collection techniques that were applied in this study were interviews, document analysis, and observation. Literature studies are also regarded as a data collection technique. This technique was preferred because the thesis was built on understanding views and perceptions of people, rather than on statistical comparisons among the statistical data. A researcher carrying out a study mainly through interviews, with physical involvement in action in the field as a participant, can gain the advantages of personal involvement such as

in-depth investigation into people and related issues and enabling observation or participation in action

Data Analysis Method

The collected data was analyzed using comparative analysis. The existing cloud service and technologies reviewed from different kinds of literature and compared with the result of the collected data.

3.3.2 Tool and Technologies

There are several open source cloud-enabling platform which can provide a well-structured tool for the cloud management and complete server and storage virtualization, from such tools the researcher used OpenStack and Xen hypervisor.

OpenStack is open source software which anyone can use to make both private and public cloud [14]. The focus of OpenStack is "to build the world open source cloud computing platform which will reach require of public and personal clouds irrespective of size by being easy to implement and massively scalable" [15] .

Citrix XenServer 6.5 is the complete server virtualization platform from Citrix. The XenServer bundle incorporates all you need to create and manipulate a deployment of digital x86 computer systems jogging on Xen, the open-source para-virtualizing hypervisor with close to-local performance.

Benefits of the usage of XenServer is decreased fees, decreasing the amount of separate disk photographs that require to be controlled, with clean integration with current networking and storage infrastructures, allowing you to time desk zero downtime preservation by using the usage of XenMotion to degree to migrate VMs between XenServer hosts. Increasing availability of VMs with the resource of using High Availability to configure guidelines that restart VMs on every other XenServer host if one fails, Increasing portability of VM pictures, joined VM photograph will work on masses of deployment infrastructures [16].

3.4 Usage of IT by Government Sectors in Ethiopia

In developed countries, ICT adoption to Government Sectors has changed the way businesses are conducted in order to have a strategic advantage in their various operations. This section shows the empirical data of the study and presented data, in such a way that the description of each sectors are categorized and will be followed by its position in view of the three issues shows as the major aim of this study correspondingly as:

- ❖ Traditional IT helps for Ethiopian Government Sectors in current situation of their business operation.
- ❖ Current ICT service delivery strategy efficient for Government Sectors in Ethiopia.
- ❖ Adama Government Sectors can choose the most suitable option for any specific application or service to gain benefits into latest information technology particularly cloud computing.

3.4.1 Firms Taking Part in the Study

This phase is to decide the level of ICT utilization amongst the 3 categories of Government Sectors which have been selected for the reason of the framework. A measure of the extent of ICT usage actually means to pick out the one-of-a-kind forms of ICT applications and centers which might be in utilized in these Government Sectors. A extensive range of ICT solutions/structures starting from basic to state-of-the-art had been diagnosed as applications specially used or applied inside the Government Sectors, and those are highlighted beneath.

Category One: Services cluster

In those classes, most of the Sectors use computer systems for ordinary sports particularly inside the accounts section and for secretarial offerings. The fundamental software besides simple workplace applications used within the employer is the Peachtree entire accounting software which is used offline.

Under this category, maximum of them have no longer a web page but but plans are there to have one that could also permit as a minimum to offer provider on line. The interviewee believes that the understandings of internet-based totally IT solution are developing very speedy in Ethiopia in latest years. The remaining step, according to them, is building the infrastructure capability and introduction of a higher carrier that lets in adoption of on line structures. Finally, all of them have a little belief approximately cloud computing generation.

According to the interviewee pointers, corporations in Ethiopia aren't catching up with the rest of the world due to the fact that there are limitations of infrastructure and the offerings required to utilize the opportunities that would be grasped by making use of the internet technologies. The strategy to these, the authorities has to construct and introduce latest net technology and its police.

Category Two: Economy Cluster

In these classes, most of the sectors have its personal custom made utility software that is used to music inventory of items, file statistics, produce numerous forms of receipts as required and generate reports and keep the database. The bills segment uses the records generated by using the device to procedure the finances the use of special accounting software but now not without delay linked to the custom made software. Some marketing supervisor says, "We recognize our business enterprise's usage of the accounting software because it has enabled us to have an awesome performance in stock and accounting statistics. This shows that we have the capacity to undertake greater new IT systems."

Some of the Sectors have an internet site of its very own where it introduces the offerings given and makes use of it as a gateway to the global market. Identifying Customer and speaking with purchaser are completed through the internet and e-mail. According to the most interviewees, says, "The Sectors makes use of online sources to discover customer a good way to perceive Provider Company with provider high-quality and the rate of carrier they provide."

Most of the supervisor hopes for an incorporated device that would permit several functions to be mixed to result in a green performance. Since the maximum area is involved inside the retail of computer associated items, it is now not extensively laid low with the cultural constraints as might different agencies that deal with none laptop related objects. The interviewees explain this as follows; "Cultural and economic problems aren't lots of subject but instead the principle purpose for the sector for now not adopting an included machine between patron and carrier furnished in addition to communicating among its branches is mainly loss of technical information in the marketplace with good enough revel in in this vicinity". According to the interviewee, one of the expected constraints is getting the customers to make the most the net gadget as it has been achieved thru other traditional manner before.

According to interviewees 'inspiration, "We count on to get a much more efficient workflow and profitability by using using the brand new machine due to the fact getting carrier might emerge as so smooth and that permits us to get into the brand new generation of making use of information generation for commercial enterprise growth. "The interviewee additionally factors out that the technical functionality to run and preserve the device is probably any other challenges to face while enforcing the device. And IT graduate has already been hired

to work on walking the system and the software developing company that took the undertaking has promised to work with the sectors in giving education and provide after service provided. Interviewee continues to say, "...After the system is carried out and starts off evolved to work well, we are able to attempt to undertake or integrate other systems inclusive of the accounting software program to make our paintings even greater efficient."

The proprietor believes that there are numerous possibilities for Government Sectors in Ethiopia in adopting facts technology into the everyday workflow for the reason that now not a whole lot has been exploited in this location. According to the interviewee, many new groups are rising into the marketplace and this makes the want for adopting such today's internet era even extra timely and necessary. Interviewee conveys their view on the possibilities by means of saying, "The financial, technical, and service readiness are developing from agencies and consequently it's miles inevitable that many such technologies have to be adopted in the coming years. However, we need to undertake e-Government within the marketplace and train our body of workers as well as rent professional ICT personnel on parallel to the desires of servants in addition to customers who need the service on line."

Category Three: Production Cluster

In those classes maximum of the sectors, computer systems are available in the most workplace particularly used for secretarial functions and the opposite machine utilized in such zone is the accounting software, Peachtree, and QuickBooks and Some of the sector use Microsoft Access is used for keeping database each used offline. Email is used for communications and a web page is used only for commercial functions at gift but some sectors are already within the technique to get a brand new gadget that allows clients to vicinity provider on-line.

Communications are made thru emails with clients and potential suppliers for import and ability markets for export are continuously researched on the internet via the marketing personnel. Most sectors have an internet site on which it keeps up to date data on the gadgets for its cutting-edge and ability clients, but not frequently.

Some the interviewee puts the plans in enhancing the functions of the internet site with the aid of pronouncing, "We are now at the very last degrees to put into effect our new greater dynamic on-line machine that allows our client to put orders and get specific statistics about the transactions between the two events by way of allowing them to have their personal bills

on which they might trace data along with the sorts, volume, and fee of objects beneath transaction; reviews on the reputations or progress of goods in transit and so forth."

Most interviewers placed their expectancies from the online gadget by way of saying, "The advantages of this system might be precious for us and our partners in enhancing overall performance with the aid of facilitating communications to be spark off and accurate. This might boost up our transactions and convey extra sales turn over the quantity and greater income. It could additionally assist us to grow into a greater global and advanced competitor inside the market. "According to the interviewers, one of the motives for the corporation no longer to hire a greater dynamic online system earlier is the unavailability of experienced specialists in machine improvement less expensive by means of small agencies within the marketplace.

They gave the commentary at the modern and capability situations pronouncing, "Businesses inside the united states can gain from ICT and the internet if we involve ourselves within the global advancement by using adopting useful systems just like the on-line system and secure transfer of payments. The government need to additionally strive to offer the essential floor in the infrastructure required as well as policies and policies for such services to facilitate the growth of companies in Adama City for the reason that contemporary financial coverage on transfer of budget is tight."

Generally the government sectors that clustered above are: transport, vital registration, job creation & food security, revenue, planning & economic development, trade and market development, revenue, culture & tourism, land development and management, education, investment, agricultural development, women & children affairs, finance and economic corporation, labor and social affairs, Sport commission, court, health, government communication, mineral resource, Attorney, peace and security are the main one.

Cloud computing offers government sectors more flexibility than traditional IT infrastructures. With a cloud service provider, there are no more worries about limited resources, buying and housing servers and hardware, updating software, or data protection. Using the cloud makes it easy to add and change services without the hassle of adding or removing digital space. This flexibility also comes in handy during risk management procedures, which require more power and space but only for a limited time.

One major benefit of cloud computing is the money it saves. By utilizing the cloud when more space or computing is needed, the cost of additional servers and hardware is eliminated,

cutting the overhead of any project significantly. Additionally, once systems are moved to the cloud, there's no need to house hefty, heat-producing servers, reducing the amount of money and energy spent keeping those machines running and cool.

The cloud simplifies collaboration between government sectors. Names and credentials can be assigned to data or documents, and only those individuals can gain access. More than just sharing documents, the cloud also allows government employees and contractors to access documents from anywhere in the world, as long as there's internet access to reach the cloud.

3.5 Data Analysis and Results

3.5.1 Data Analysis

This study was intended across three categories of cluster such as Production cluster, service cluster, and finance cluster. These clusters are the most important aspects to examine the current ICT usage and practice. Analysis of necessities through comparative analysis technique of statistics acquiring from number one facts with applicable literature locating for offering the necessities to constructing the cloud computing framework that intended in this look at; In the literature reviewed on this take a look at, there have been concepts of cloud computing adoption. Accordingly, interview and related literature evaluate are hired for this examine to broaden the expertise this is required for proposed framework for cloud computing adoption.

In this part of the data analysis, reports about the levels and purposes of ICT utilization within the selected sectors were described and presentations in the table.

Table 4: Type of sector clusters involved in this research

Government Clusters	Frequency	Percent
Production	3	20
Service	8	53.33
Economy	4	26.67
Total	15	100

Table 4: Shows that the type of sector involved in this research is Manufacturing 3 (20 %), Services 8 (53.33 %) and economy 4 (26.66 %).

Table 5: ICT usage under the selected category

Same question in selected sectors	Status of IT usage	Frequency	Percent
If you are an ICT user for what purpose you use it?	Eight of them have websites	8	26.6
	Three has a database	3	10
	Ten use accounting software	10	33.3
Do you have challenges when you use ICT for your business?	High cost of ICT infrastructure	28	100
	Lack of qualified staff		
	High cost of software applications		
Do you think the current ICT services and supports that are provided are enough to achieve your business goal?	Strongly disagree	3	10
	Disagree	15	50
	Agree	8	26.6
	Strongly agree	5	6

Table above of the research has shown that from the total (28) the respondents 8 (26.6 %) have websites, 10 (33.3%), are used accounting software while minor respondents 3 (10 %) are used the database. Moreover, the study revealed that all of the respondents which is 28 (100%) of the respondents answered that high cost of ICT infrastructure, lack of qualified staff, the high cost of software applications. This table also has shown that a large number of respondents 15 (50 %) of the respondents disagreed that Information Communication Technology services and supports do not provide enough to achieve your business goal of service, while 3 (10 %) of them are undecided. Moreover, the study has confirmed that some of respondents 8 (26.6 %) of the respondents disagreed that ICT does not help in attaining sectors satisfaction in business operation.

The fact of presidency Sectors in Adama, Ethiopia according to the above supplied on the examiner, they have got now not been in a position to utilize the online machine as expected and its consequential fewer advantages on a full-size degree. Their exceptional success from ICT to date is having static web pages and some with little extra features like accounting software and database of products, suppliers or customers. Most of these firms are handiest on planning levels to adopt a few number one stage on-line gadget and haven't invested in it but.

Almost all the respondents have agreed that there's a loss of dependable and cost-effective infrastructure to put into effect the accurate Internet-based IT systems in keeping with the dominant situations to the Adama city in addition to the precise organization.

Our respondents have also mentioned that now not enough infrastructures have a terrible impact on the confined lifestyles of ICT utilization in the country. They add, that is mainly because of the monopolistic and very highly-priced provision of Internet offerings by means of the authorities-owned EthioTelecom.

In this part, a brief comparative analysis was performed in order to determine of the frameworks suit meets the research objectives. One of the main criteria used in this comparison is the alignment of existing cloud service and technologies with the result of interviewed data. The result gave us a new perspective, how cloud computing was seen from the business world. The problem is often that cloud computing was not get the proper chance in competition with traditional IT solution because of the lack of skill. We found under the research that some companies were hesitant to move into the Internet-based IT solutions; therefore, the result from this study was given to find information about the low knowledge of cloud services. The collected data have in less fulfilled the expectation to adopt Government Sectors to cloud services.

This take a look at indicated that the Adama Government Sectors have low recognize-the way to undertake this new generation. There is need to teach the employee and show the patron the ability presented through using this technology. So a long way most of the sectors do now not know why they have to forget about this era prior to different to be had technology, but cloud computing has numerous benefits over other cutting-edge technologies.

The generation of cloud services specifically includes many components that consist of a cluster of computing, centralization of statistics, broadband community, and grid computing. This element is being used considerably and specifically in special sectors and agency. Cost saving is one of the key benefits of the cloud computing offerings. The saving isn't first-rate in money however additionally in time and effort needed to the function the device and conducts the sectors. Therefore, this study has developed cloud architecture to provide adoption cloud services. While the data that was gathered through this study may not be sufficient to be generalized as a framework, it is enough to identify the prominent challenges and give insights about the current state (in cultural and legal aspects) and role for adopting cloud computing in government sectors in Adama with a minimum infrastructure cost and resource consumption to migrate to the cloud.

3.6 Summary

The summary of this section address ICT that used to improve the activity that made by government sectors at every step of their business process; Even without Internet connectivity, government sector can use PCs for basic word processing, accounting, database and other business operations. Appropriate ICT can help government region cut charges by way of enhancing their internal methods, enhancing their product through quicker conversation with their clients, and better selling and dispensing their merchandise through cloud computing.

Users have a reason for adopting cloud computing into their business. In most cases, there is a business process that can be replaced with a cloud service to get a cheaper and a more effective way of doing a particular business process. That is why cloud computing is a good option since you do not have to worry about the technicalities as a user.

Currently, Cloud Computing is experiencing a strong adoption in the market and this trend is expected to continue. But without a well-defined adoption strategy to supports cloud computing abilities, migrating in the direction of cloud has no experience from the financial point of view because it ends in excessive expenses with the re-engineering of existent systems. The outstanding cloud adoptions strategies that are agreed in lots of experts and companies have blanketed the following stages as illustrated within the beneath.

3.6.1 The readiness of government sectors in the Clouds-Needs and Requirements

This includes the wishes of Government Sectors, requirements and desire to undertake cloud computing. These desires can be recognized at various ranges, for example, the need for guidelines and policy may be at the countrywide, enterprise or even individual cloud client degree. Literature that gives insight to those distinctive ranges of desires and requirements are suggests readiness of the government sectors.

3.6.2 The processes of adoption of cloud computing for ACGS

The adoption of cloud computing via ACGS presenting factors or determinants of ACGS adopt the cloud as well as research that spotlight the adoption manner of ACGS, migration to the cloud, and implementation and cloud integration troubles. Processes of adoption include problems including assessment in phrases of price and cloud issuer choice; adoption decision, integration and IT governance and utilization and continuance problems.

CHAPTER 4

PROPOSED FRAMEWORK

4.1 Background of the Framework

After assessing the current state of knowledge surrounding ICT usage in ACGS and these compared with existing approaches and then compiled into a comprehensive framework for a cloud adoption. Thus, in this section presented about the proposed a framework for cloud adoption that helps to efficiently utilize the potential of cloud computing as the latest information technology solution to add value for ACGS.

4.1.1 Need for a Framework for Cloud Computing Adoption

Traditional IT systems had been extra complex and steeply-priced to hold and are not capable of meet commercial enterprise demands seeing that they lack flexibility and scalability. Cloud computing is the answer to the issues which can be presently being experienced by way of sectors that still have the traditional on premise IT systems. Cloud computing saves prices with the aid of putting off the need for excessive infrastructure prices and additionally presents a smooth to use, flexible, dynamic and secure surroundings for organizations to behavior their business.

Cloud computing combines multiple technologies and capabilities with a new business and operational model to create a new service delivery model. For these reason, adoption of cloud computing carries architectural, financial and organizational impact. Cloud computing enables

IT to become a true service provider that efficiently supports the business needs of the organization.

Conversely, [60] raised some concerns in regards to the usage of those services. He said that vendor lock-in and screw ups are foremost issues encountered while using the Cloud services. Many service providers provide their services through proprietary interfaces, and there are not any Cloud Computing requirements for APIs (Application Programming Interface), the storage of enterprise data for recovery, and the import and export of statistics if corporations want to exchange providers. Additionally, the failure of a cloud dealer that shops the statistics can have a severe effect for the give up users who trusted their information with their decided on dealer.

4.1.2 Identifying Cloud Services and Deployment Models

In order to formulate a proper framework, we start with the identification cloud services and deployment model. There are a wide and increasing number of providers of “Cloud”, and it is open to debate whether a particular offering comprehensively matches the set of characteristics that NIST or any other organization might use to distinguish a “pure cloud” offering from some technology. The rent of cloud services needs to decide what the required features are. It is apparent, however, the commercialization of software, software development and systems can offer alternative ways of doing “traditional” activities. Indeed, for some, IaaS, PaaS and SaaS could be used to replace a significant majority of extant IT systems entire businesses could run “in the Cloud”.

Identifying Deployment Models

There is several cloud deployment fashions are to be had. Firstly, the public cloud infrastructure, that's made to be had to the overall public or a huge industry institution and is owned through an employer imparting cloud offerings. Secondly, the non-public cloud infrastructure, this is operated and controlled solely through way of an company or it may be controlled through the use of a third birthday party and may exist on premises or off premises. Thirdly, a hybrid cloud is a composition of or more cloud environments, wherein a enterprise provides and manages a few resources in-house and has others supplied externally thru a public or community cloud.

By thinking about the expertise derived from the literature and intention from the interviewee result the researcher determined to suggest a hybrid cloud transport version for ACGS. The formula of a hybrid model, then, based totally on a number of variables, a particular institution’s software, and infrastructure requirements. The proposed hybrid cloud model could have capabilities to mix cloud and non-cloud IT infrastructures which includes non-public, shared and traditional IT inside ACGS. The proposed hybrid transport method allows ACGS to accelerate pace-to-market by way of better aligning IT and the enterprise itself. By integrating traditional IT and private cloud-based totally services with the brand new neighborhood cloud provider issuer, this hybrid technique protects current investments in ACGS. By leveraging bendy sourcing and utilization-primarily based pricing, it could assist to lessen each capital and operating charges of ACGS. This hybrid cloud component will strengthen important hazard and safety control that have been taken into consideration as the primary barrios on latest records generation adoption from the usage of outside public cloud provider issuer in ACGS.

Identifying the Type of Cloud-Based Services

The cloud-based totally offerings have been selected and recognized based totally on the wishes of the ICT surroundings for ACGS. The following sections speak the three sorts of cloud offerings:

SaaS is one of the cloud-based totally offerings which allow person's access distinctive software from the cloud wherever there, and each time they want without installing it on their device. In SaaS users can access unique software program from the cloud: CRM, E-mail, Virtual Desktop, Office packages, Sector Resource Planning (SRP) and distinctive Business Information gadget packages, like middle finance systems, HRM device.

Platform as a Service (PaaS)

Platform as a Service provides a solution stack, that's an integrated set of software program that gives the entirety a developer wishes to assemble an software for both software development and runtime. The proposed hybrid cloud will offer developer device as a provider to assemble services, or facts get right of entry to and database services at the cloud. The developers who seek to broaden and run a cloud application for a specific platform can get right of entry to those offerings the usage of the interface offered to them. The developer interacts most effective with the platform through the proposed hybrid cloud interface, and the platform does what's necessary to manipulate and scale it to provide a given stage of service. Using the cloud, developers do now not want to physically installation any particular services, solution stacks or databases on their system. The hybrid cloud gives the subsequent services for PaaS customers: working device and Storages (database and document garage).

Infrastructure as a Service (IaaS)

IaaS is some other mechanism to supply hardware together with servers, networks, statistics middle area and others, which lets in cloud customers to host/run their statistics/applications at the company computing infrastructure. The proposed hybrid cloud can provide these infrastructures using virtualization generation at one place to all ACGS. Under this cloud provider version, the company manages and continues the website hosting and the development environments. By consuming IaaS cloud ACGS can lessen infrastructure cost and complexity thru its abilities of fast provisioning, potential to scale up/down and pay handiest for what they use. The hybrid cloud provides the subsequent services for IaaS customers: Virtual system, storage, community and so forth.

4.1.3 Selecting Cloud Service Providers

Organizations select cloud deployment fashions for IT answers based totally on their specific commercial enterprise, operational and technical requirements. Since the assessment allows to the sectors to pick the right cloud solution. This study identified the potential cloud services such as IaaS, PaaS, and SaaS, while hybrid cloud deployment model is proposed for ACGS that could best meet the most business operation and service requirements of ACGS.

Identification and selection a proper cloud provider is the most important part of the implementation plan. Different providers may offer different service models, pricing schemes, audit procedures, and privacy and security policies. Also, it needs to evaluate the provider's standing and performance before it signs a contract.

Afterward, the researcher includes those clouds that afford a great amount of service. At the last stage, CSP selection was depending on the ease of the use and the existence of ongoing technical support services.

Cloud Computing has completely changed the conception of infrastructure architectures of a number of available resources and of development models. The physical servers are in reality cut up into virtual machines whose assets are bendy and scalable consistent with the requests made by customers. In this way the identical system may be shared by using more than one customers and information may be fragmented in specific places. These characteristics increase critical doubts about the safety of these structures and the ability of well governing the services furnished.

4.1.4 Architectural Requirements for Cloud

In order to optimize the advantage of a cloud computing, the interfaces and architectures ought to permit a strong interoperability and accessibility to attain out the computing resources. The different critical components which might be crucial for the structure of a cloud computing are the safety, scalability, availability, statistics migration, company degree agreement, transparency, and lots greater. Within their paper [12] Classify those elements into three predominant agencies of requirements: for quit customers, sectors that use the cloud, and the cloud issuer itself. These requirements could be discussed briefly in the following factors and incorporated with other helping literature.

Provider Requirements

From the carrier provider's perspective, the important thing worries are related to the efforts to make the value version attractive, consisting of the need to have surprisingly green service architecture and a nicely-organized and secure statistics storage mechanism. To fulfill those requirements, Service orientated architecture (SOA) method can provide a type of architectural subject which can assist to leverage the cloud computing right into a more effective and efficient IT infrastructure. These are the important thing necessities from the vendors wherein a number of the attributes from SOA may also be described:

- ❖ **Service-centric issues.** The cloud offerings have to be autonomic, self-describing, and green within the disbursed composition. By being autonomic, the layout of the cloud structures must allow a dynamic adaptation to the environmental modifications with much less human intervention. The self-describing provider interface contains the facts and functionalities which might be reusable and unfastened coupled. With this loosely coupled and green composition, the interaction with multi-programs and collaboration would be less complicated. The transactions processed within those cloud offerings should comply with ACID homes – A (Atomic) that the transaction is completely accomplished or in no way finished; C (Consistent) that the database information integrity constraints are regular from one nation to another nation; I (Isolation) that the records processing is not visible to other transaction requests till it's far finished; and Durable that even as the transaction is finished so does the update (Britton & Bye).
- ❖ **Interoperability.** This focuses specifically at the creation of an open records format or open protocol (API) to allow clean and steady interface, migration and integration of different clouds with one of a kind companies.
- ❖ **The quality of service.** The certain level of service attainment is mounted on the way to guarantee a enough overall performance and availability, as well as the alternative great components along with the security, dependability, reliability, etc.
- ❖ **Fault tolerance.** The faults may be remoted most effective to the falling components and save you the opposite offerings affected. For this, right tools and mechanism including a sure utility for self-healing and self-diagnosis are vital.

The different necessities that require careful remedies are the statistics control and garage to make sure the statistics replication across geographic distances at the side of its availability and durability, virtualization management to address the virtual machines on the top of its

running machine, scalability to address a massive set of records operation in cloud, and finally the load balancing to have a self-regulating mechanism to reveal the workload belongings in the cloud.

User requirements

The principal issues coming from the cease customers are the privateness – a way to ensure the sensitive facts stored in cloud protected from misuse, the provider stage settlement – whether the cloud provider company is able to deliver the services thus with the pre-defined agreements, the adaptability, and getting to know – the helps to make the customers sense acquainted with the cloud systems, and the person experience – to provide insights to customers which can help them to apprehend the potential, usability, desirability of the applications.

Service Level Agreement:

The benefits presented through resource scalability and pay-as-you cross approach assessment with the low standardization and the continuous exchange of systems. Therefore, to make sure first-rate and continuity of service, a clear Service Level Agreements (SLA) between customers and companies is important. The lack of a particular set of metrics complicates management, in particular when services are across many companies. Other factors, as consider in the cloud carriers, come to be essential to companies which can be clouding vital facts.

The research regarding SLAs, consisting of the Quality of Service (QoS) metric, template, frameworks has been widely carried out via the researchers, especially for provider-orientated related structure. However, the same research for cloud computing isn't always available within the identical amount. SLA metrics from such structure and technology aren't at once appropriate for cloud because its nature and resources being delivered are special. The key residences that must be documented within the SLAs are as the subsequent:

- ❖ A clear description of the service
- ❖ The level of expected performance of the service
- ❖ The service parameters to be monitored and the format of monitoring exports
- ❖ Penalties when the service requirements are not achieved

Functional and non-functional requirements for cloud customers are requirements set the expectations toward the cloud services and should be fulfilled by the providers. The non-functional requirements can be the source for criteria in SLAs, such as:

- ❖ **Availability** – the probability that the cloud services are available in the specific time of utilities.
- ❖ **Scalability** – the specific resources are provided in order to facilitate the ease of scaling up and down.
- ❖ **A clear cost calculation method** – since the billing is based on the utilization of the cloud services, a certain mechanism should be established in order to allow the customers trace their use.
- ❖ **The configuration of service** – the cloud services can be configured in a flexible manner in order to minimize the system changes performed by the customers.
- ❖ **Security and privacy** – the sufficient protection of the critical data by the cloud service providers.

4.2 Building the Framework

According to the evaluation result of this observes showed that the prevailing Information Communication Technology (ICT) investment and usages in ACGS in Ethiopia were described as inadequate. Propose a green ICT investment and usage method to support the ACGS sports through recent technological model i.e. Cloud computing version. This Cloud-based totally Issuer allows remedying barriers of the current ICT utilization in ACGS.

Through taking these into considerations the researcher determined to propose hybrid cloud model for ACGS. The proposed neighborhood cloud service company could be fashioned and geared up with essential cloud era infrastructure that may be a provision as a service to ACGS primarily based on their specific IT infrastructure requirements the usage of cloud computing commercial enterprise version. This cloud provider will offer scalable, elastic and reliable sources to the users. This cloud provider company creates digital computing resources out of bodily computing sources and allocates the digital computing assets to distinctive users. In this approach a couple of users share not unusual physical computing assets.

The cloud-based services offered by the proposed cloud service providers could be:

1. **IaaS** which deliver infrastructure resources includes servers, storage, and networking.
2. **PaaS** which offer developer tools as a service to build services like operating system database system.
3. **SaaS** which delivers domain-specific applications or services over the Internet including collaboration and communication tools, Office applications, and different

business Information system applications (like Accounting software, HRM system) and other Application Software can be hosted.

Therefore, the proposed hybrid cloud model allows users to run the different workloads on local cloud service provider infrastructure or platform services.

The Proposed framework namely Adama City Government Sector Hybrid Cloud (ACGSHC) is a set of common and shared services and contains four layers (User Interface, SaaS, PaaS, and IaaS) and three modules (User log database, system security, and service management): Based on the identified and selected clouds-based services, the researcher proposed a Cloud Computing Framework Ecosystem for ACGS providers. The next figure shows a general layout of the Adama City Government Sector Cloud Ecosystem based on the cloud computing with an interface layer to control the user's access to different services. Virtually the cloud services can be deployed and run on the proposed carrier provider bodily IT infrastructures. Users of cloud services are personnel, clients and other users of the ACGS. Adama City Government Sector Hybrid Cloud has an interface for others cloud provider. Users can shop their information and get right of entry to virtual machine instances (software packing containers) on cloud computing infrastructure without problems. Users can create digital gadget photograph, launch the specified services and terminate the virtual machines via cloud interface. Computing sources will no longer go out however features by means of developing a virtual system instances (software bins) on cloud computing infrastructure easily. Users can create virtual system photo, release the required services and terminate the digital machines via cloud interface. Computing assets will now not go out but features via developing a digital model of an IT aid along with OS, a server, Storage tool and Network aid on rent base whilst wished. Version of an IT aid consisting of OS, a server, Storage tool and Network useful resource on rent base whilst wished. Based on the diagnosed cloud services version mentioned in the above framework, in historical past the researchers proposed a collaborative cloud computing architectural framework for ACGS. The following parent suggests the proposed Adama City Government Sector cloud framework.

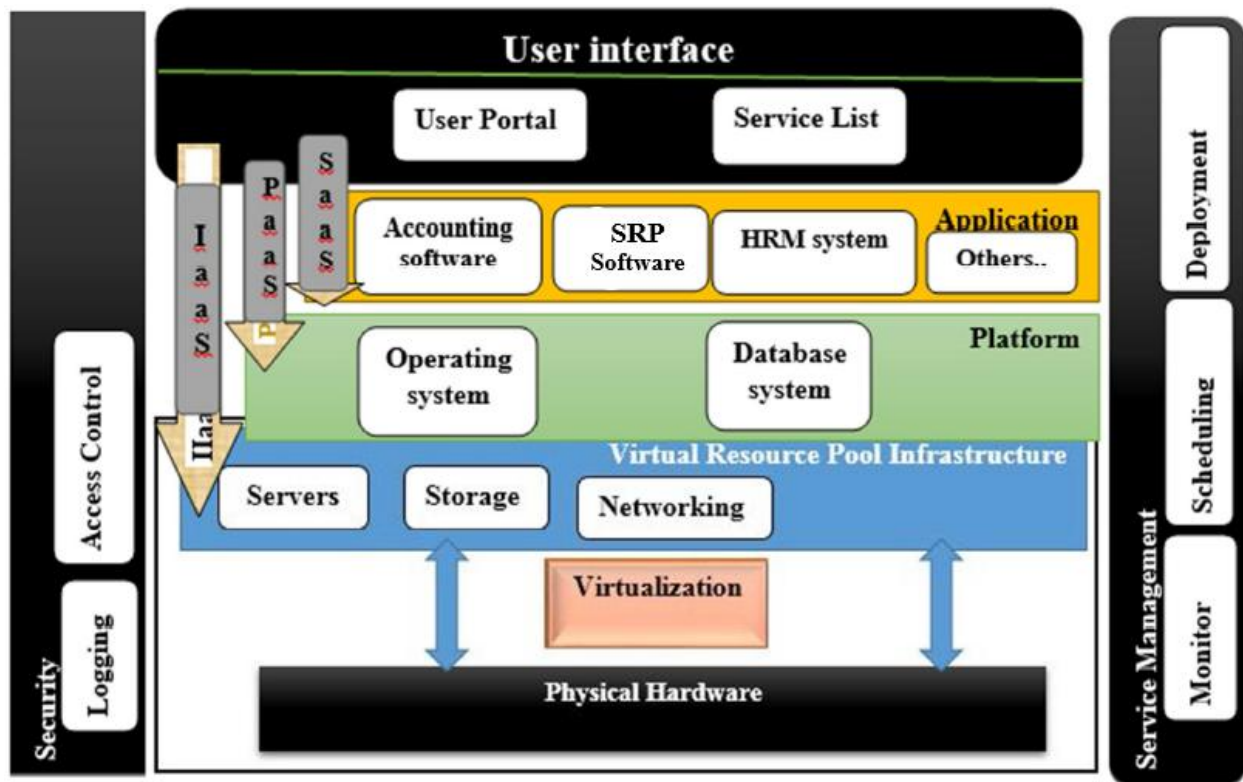


Figure 10: Proposed high-level cloud-based service delivery architecture

4.2.1 User Interface Layer:

This layer acts as an interface among the person and the cloud content material. Access to every cloud offerings is protected via the Authentication and Authorization mechanism because applications and statistics are hosted out of doors of the company in the cloud computing environment. This permits users to access the cloud services in a safety-wealthy surroundings.

Authentication means that every consumer has an identity which may be depended on as authentic. This is necessary due to the fact a few assets may be legal simplest to certain users, or certain classes of users. Authentication is the mechanisms wherein structures may additionally securely identify their customers. Authentication structures provide answers to the questions: Who is the user?

Authorization is the mechanism by which a system determines what level of access a particular authenticated user should have to secure resources controlled by the system.

Generally, this layer contains two important components.

- ❖ **User Portal:** provide an access path to specific web applications or services since everything is located on the web and can be accessed using a network connection.
Login, Registration & Administration
- ❖ **Service list:** provides the list of the available services in the cloud environment

4.2.2 Software Service Layer:

This layer provides access to hosted programs—applications or tools on the Cloud. Accounting software, HRM system, ERP software and other Application Software can be hosted at this layer

4.2.3 Platforms Service Layer:

This layer provides access to application hosting and development environments including operating systems and database systems another platform services.

4.2.4 Infrastructure Service Layer:

This layer offers extra flexibility when dealing with the hardware layer thru virtualization together with servers, storage, and networking at the cloud surroundings. The customers can consume the offerings actually with buying it from the proposed ACGS infrastructure provider carriers. The user can use these computing resources to run software program (each working structures and programs) and to keep statistics.

4.2.5 Service level management:

Additionally, the proposed framework has gadget safety module for retaining the safety of the cloud, service management module for tracking, scheduling, and deployment of services. The monitoring carrier also can be used by users to degree the performance of provisioned virtual machines and to decide whether new virtual machines want to be began. In a cloud device, the entirety is metered and accounted. Metered usage statistics provides for bendy pricing and charging in some cloud surroundings. Historic usage information collectively with tracking facts is vital to automate capacity making plans and ensured agreed on QoS.

4.3 Development plan for the Proposed Framework

The proposed framework will utilize IT infrastructure of the government sector which would adapt the framework namely, Adama City Government Sector (ACGS) as illustrated above. In such a situation, the framework needs to deploy a hybrid cloud model as a cloud-based solution for ACGS, which combines the local infrastructure as a private cloud with selected public clouds. Hybrid Cloud is one of the Cloud Computing deployment models. It provides

the ability to access, manage, and use third-party (vendors) resources from multiple CSPs and combines them within in-house infrastructure (private Cloud). Using such a model allowed us to avoid lock-in and was blocked with one CSP by allowing mix and match services from different CSPs. In addition, it will give us the ability to secure the sector's critical application and data by hosting them on the private Cloud without having to expose them to a third-party. With a hybrid Cloud model, the sector has more control of their system since part of the infrastructure is under their control. For this model, the research needs software which manages the complexities and the heterogeneity of this distributed data centers. So the researcher tries to professionally compare and select the different open source cloud infrastructure manager tools. The contest is among OpenNebula, Eucalyptus, OpenStack, and CloudStack.

4.3.1 Components of Proposed Framework

Many authors have highlighted that the architectural components of Cloud Computing include hardware, software, as well as their residing data centers and Cloud Computing models: service models, deployment models, and business models. For simplicity, this thesis summarizes the vital components of Cloud Computing, as extracted from existing research, in the following table. This structures the most relevant components of Cloud Computing, and identifies the components that will be used in developing the initial Cloud Computing framework. The seven most relevant components identified for the purposes of this research

- ❖ Essential Characteristics;
- ❖ Models;
- ❖ Technology Architecture;
- ❖ Interaction interfaces;
- ❖ Considerations; and
- ❖ Principles.

Table 6: Attributes for expert reviews for Cloud computing components

Major component of Cloud Computing	Sub-component of Cloud Computing	Principle factors that will influence eGovernment services in the adoption and use of Cloud Computing
Characteristics	On-demand service	Efficiency
	Broad network access	Reliability
	Rapid elasticity	Cost
	Resource pooling	Security
	Measured service	Management support

		Security
	SaaS, IaaS,	Efficiency of service delivery
		Reliability
		Availability
		Cost
		Privacy and trust
		Quality of service
		SLAs
	Public Cloud Computing and Hybrid Cloud Computing	Security
		Privacy and trust
		Management support
		Availability
Technology Architecture	Data centers Virtualized hardware and network infrastructure Application software	Availability
		Cost
		Management support
		Performance
Interaction interface	Smart phones, tablets, notebooks & personal computers Web portals	Availability
		Cost
		Usability
	Service Level Agreements(SLAs)	

Based on the most relevant components of Cloud Computing explored and identified by this thesis the first version is represented as follows.

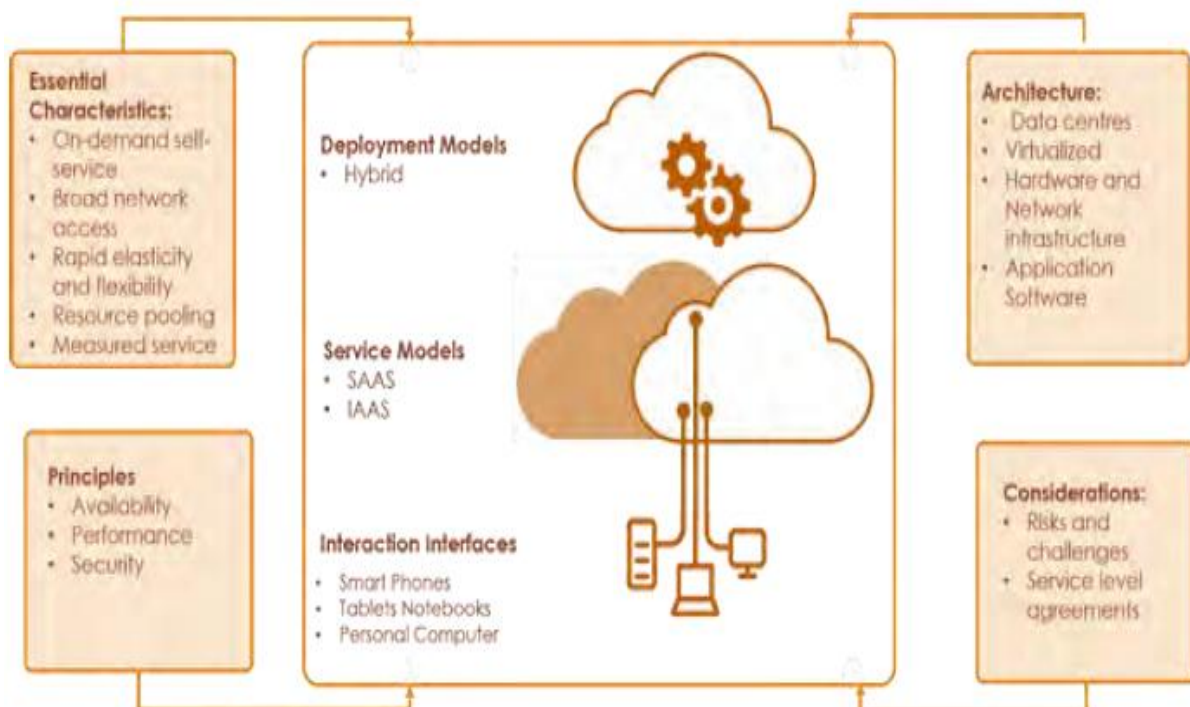


Figure 11: Diagrammatic representation of the proposed framework for ACGC (V1)

Using these building blocks, the second version of the theoretical framework was developed in as follows.

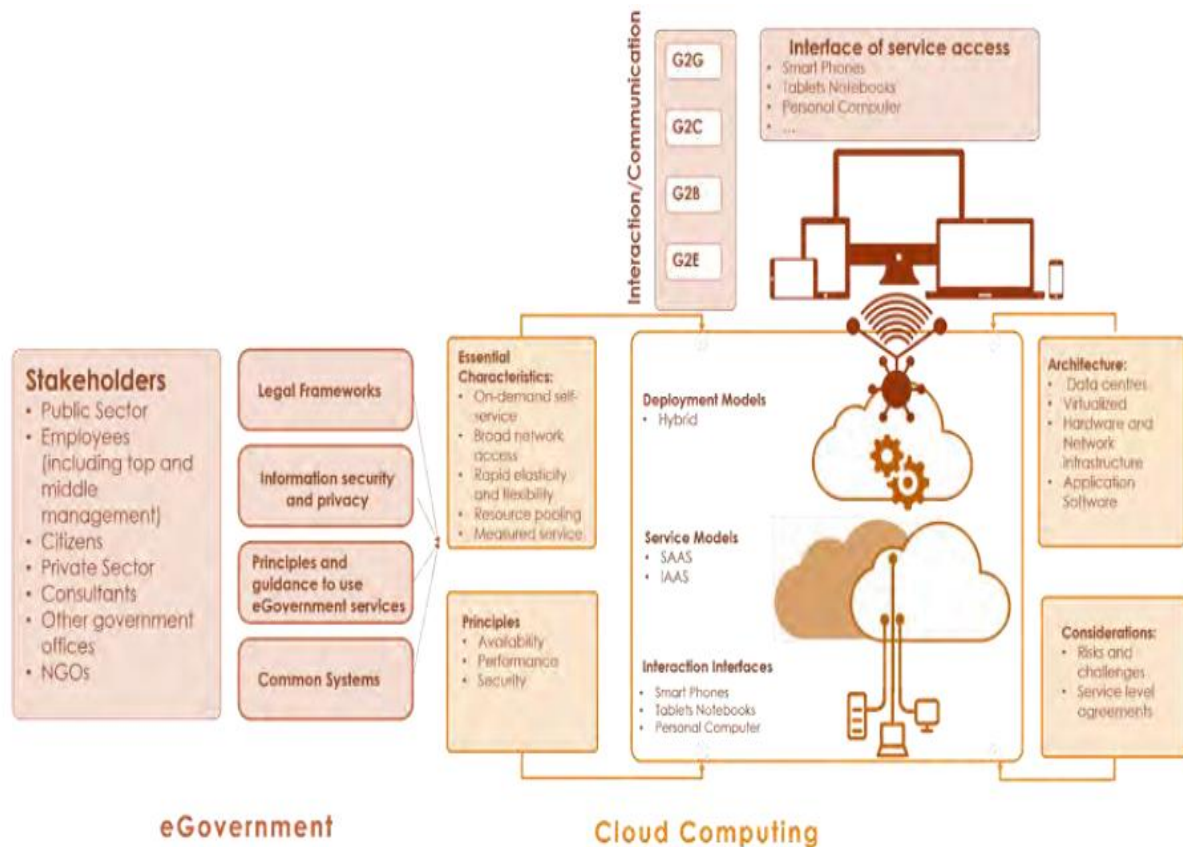


Figure 12: the Second Version of a Cloud computing frame work for ACGS

These V1 and V2 interim theoretical frameworks provided a number of components that are closely related to solutions, in order to address the challenges posed by RCEs to Cloud Computing for facilitating eGovernment services.

4.3.2 The Final Framework

Change is required to enable the application of new technology, such as Cloud Computing technology, within the existing system. Thus, an initial framework for Cloud Computing in resource-constrained digital environments to facilitate eGovernment services was developed. It was re-developed by including components from eGovernment services, and further developed by including components from RCEs, components of Cloud Computing, eGovernment services, and resource-constrained digital environments.

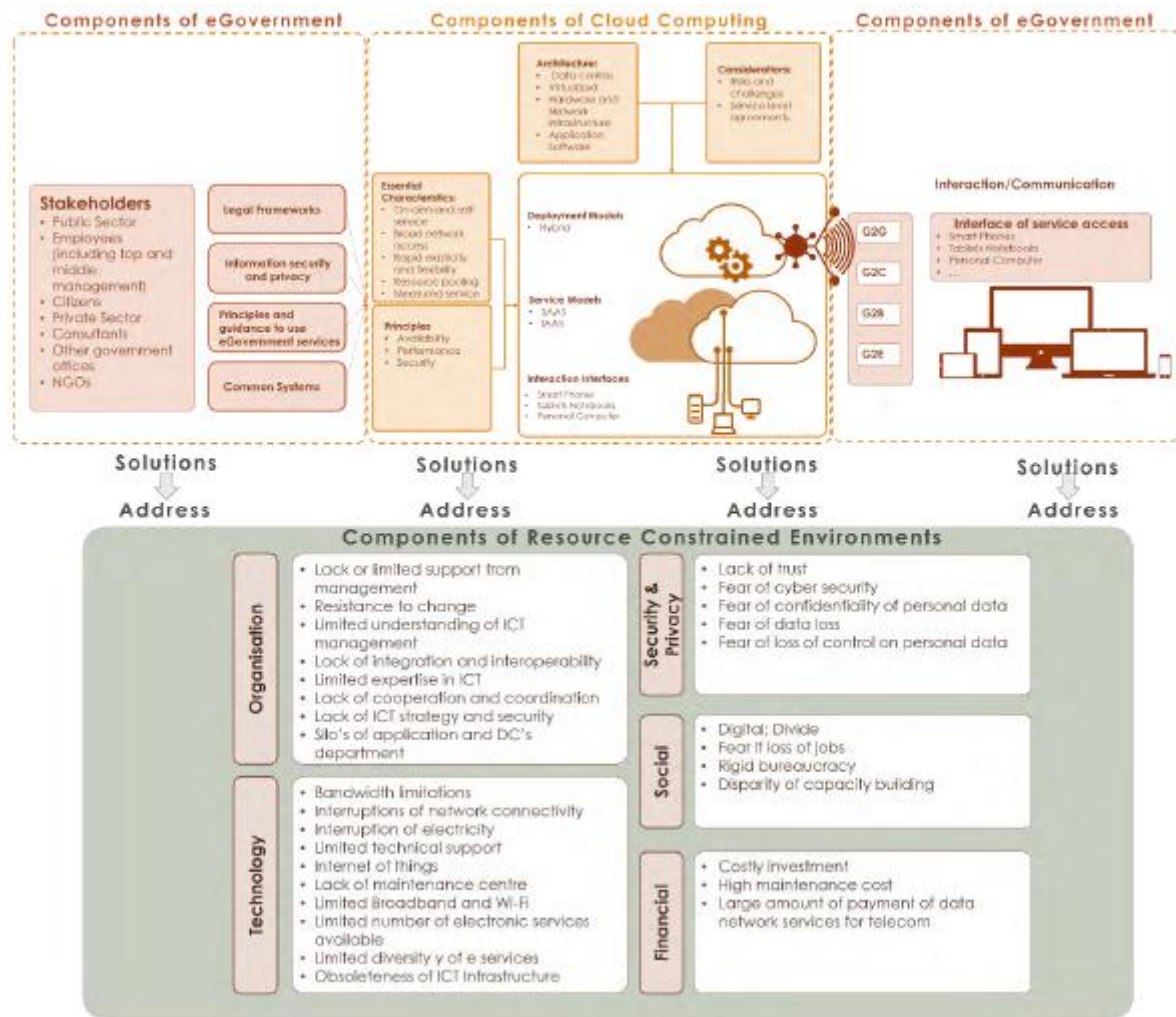


Figure 13: The final version of a Cloud computing frame work for ACGS.

The discern bellow shows a top level view of the selected Cloud and the way the content will be arranged within the personal Cloud. Within six steps, the person can use a resource and then launch it; those steps are illustrated in the following factors:

- 1- The user sends a request using the ACGSHC interface
- 2- The verification of the authorization degree will be checked the usage of the person profile personal Cloud.
- 3- If the person is unauthorized to request such services, the gadget will reject the consumer's request; in any other case, the request might be sent to the digital infrastructure supervisor(OpenStack) to redirect the request to the best vicinity for either public or personal Clouds.

The subsequent discern shows an overview of the proposed Hybrid Cloud Computing version for Adama City Government Sectors.

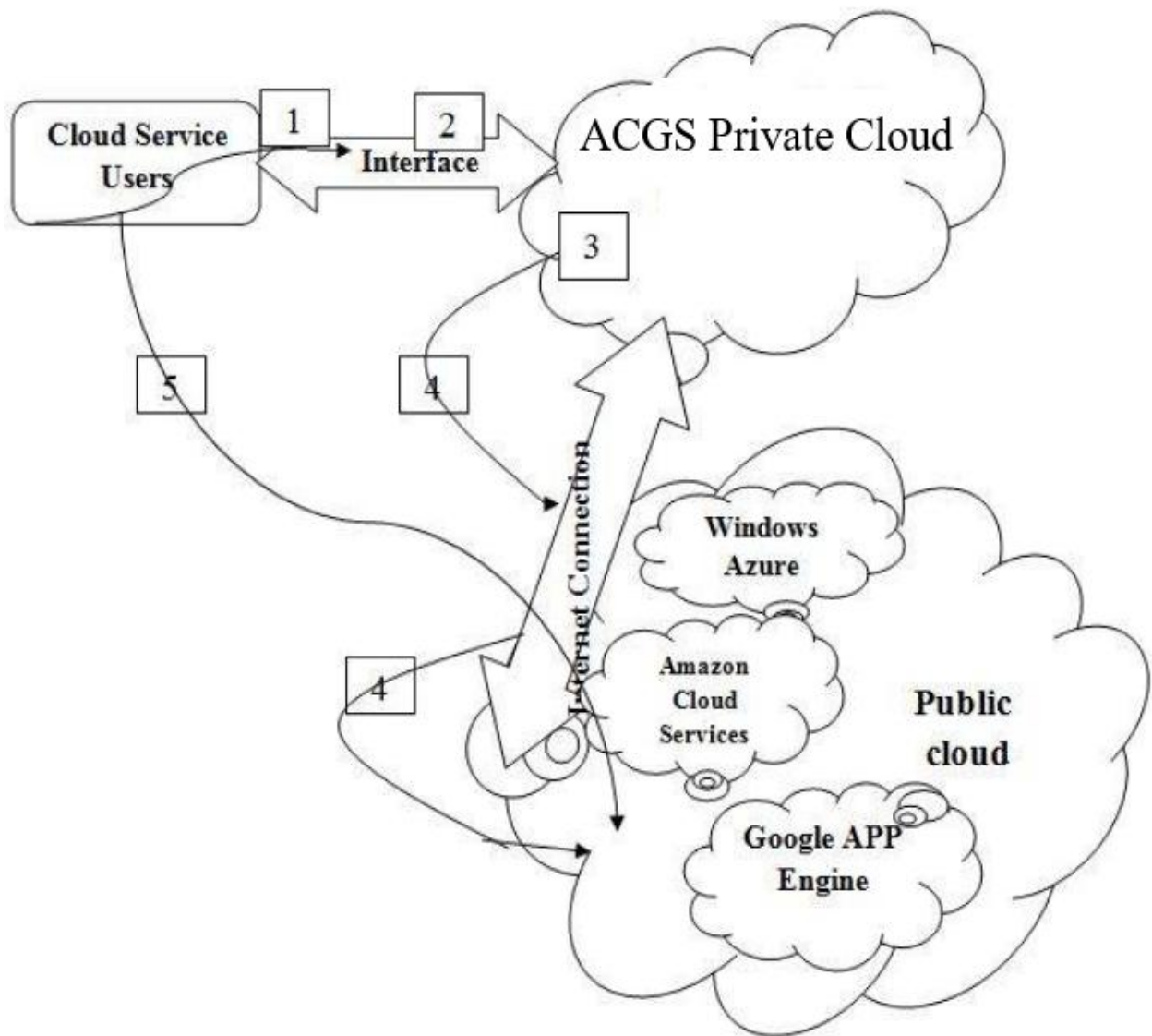


Figure 14: An overview of proposed a hybrid cloud for adama city government sector

- 4- The gadget will set up a connection between the requested services from the Cloud and the person.
- 5- As lengthy as the user wishes the aid and does not exceed the most utilization length, the device synchronizes the carrier transport among the person and the useful resource.
- 6- When the user is carried out and not desires the requested aid, the gadget will terminate the consultation and disconnect the user from the goal Cloud.

CHAPTER 5

DEMONSTRATION AND EVALUATION

Implementation of a prototype details serves as a demonstration of the approach. The proposed work involves the implementation of a prototype private cloud setup with an open source cloud software platform which can provide a well-structured tool for the cloud management and complete server and storage virtualization, from such tools the study used such as OpenStack and XenServer. The evaluation of performance of the proposed work with Infrastructure-as-service configuration:

5.1 Prototype for Proposed Hybrid Cloud Implementation

In the previous chapter we have proposed high-level cloud-based service delivery architecture, these implemented using various open source technology. As the prototype is completely developed in the open source environment, most of these tools were downloaded from the internet and installed from source codes. The documentation that comes with most of the open source software was used to install and customize the modules.

Private cloud is a virtual IT infrastructure that is controlled and operated by the organization. OpenStack and Xen virtualization open source technology is adapted to the construction of private cloud in this paper because of the characteristics they have. For building a private cloud using Open Stack is introduced which is capable of serving the user request for infrastructure and platform services. The next figure shows an overview of the proposed Hybrid Cloud Implementation Architecture based on OpenStack and Citrix XenServer for the proposed framework.

The following list describes about implemented of the proposed hybrid cloud architectural framework components:

5.1.1 Infrastructure layer:

In the IT Infrastructure will be placed at the bottom of this layer since ACGS private Cloud would be built on top of the available infrastructure. Furthermore, these physical infrastructures will be virtualized using XenServer which plays a critical role in the infrastructure layer. XenServer is a complete server virtualization platform, optimized for both Windows and Linux virtual servers, with all the capabilities required to create and manage a virtual infrastructure.

Government Sector private cloud is built on a computer cluster of multiple physical machines. Physical assets within the machine include pc nodes like quarter servers and scattered PC, as well as switches and routers. XenServer works by means of abstracting elements from the bodily device (including difficult drives, sources, and ports) and allocating them to the virtual machines going for walks on it. A virtual device (VM) is a laptop composed entirely of software program that can run its own working system and applications as if it has been a physical computer.

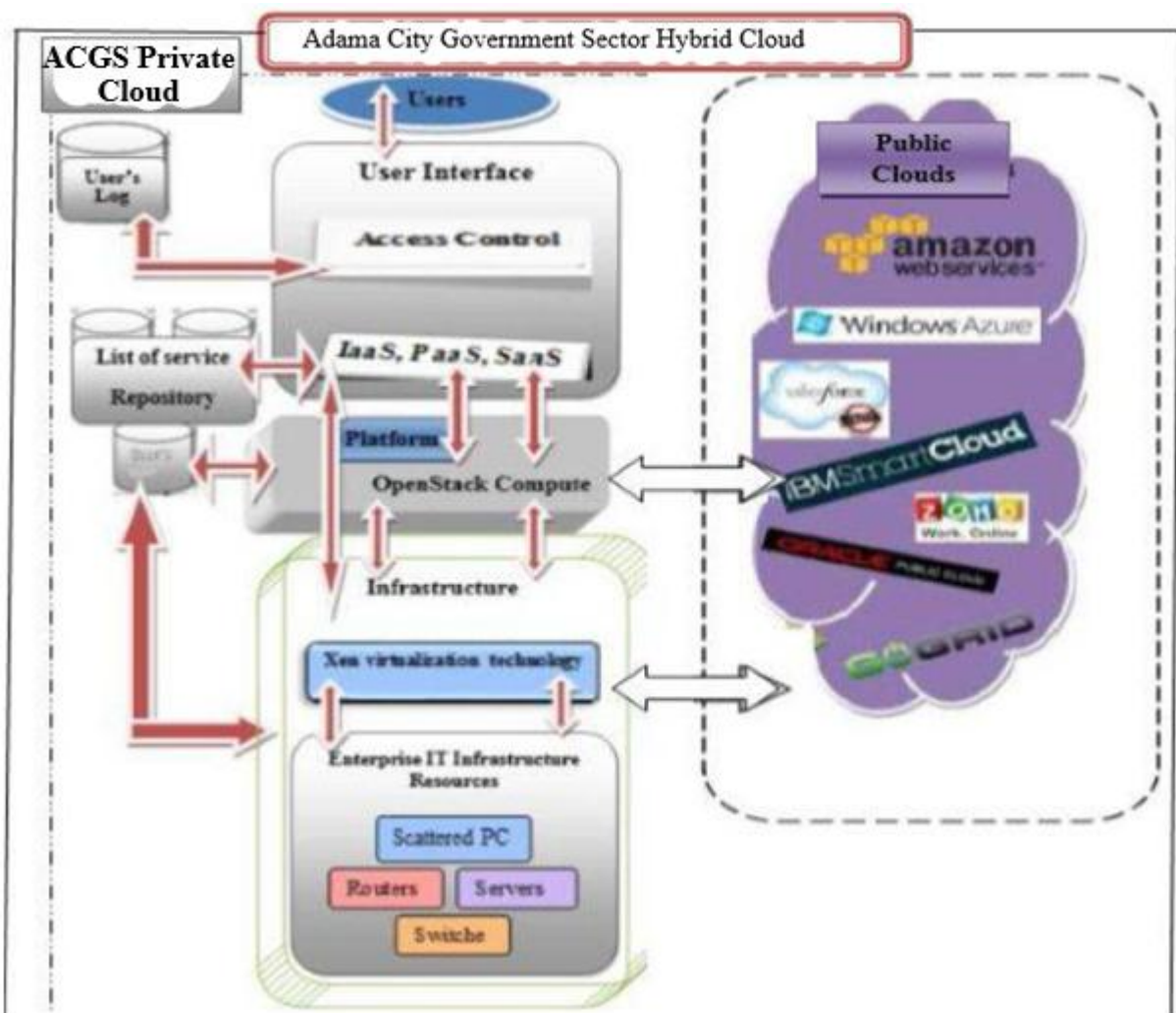


Figure 15: ACGS hybrid cloud implementation architecture based on open stack

A VM behaves exactly like a physical computer and incorporates its very own digital (software program-primarily based) CPU, RAM, difficult disk and community interface card (NIC). The device can also recycle those virtual sources and recognize start, prevent, migration and recovery control of the digital gadget. This layer is transparent to users, and

there is no distinction among the digital system and the overall bodily system to users. When making virtual pictures, software and services also can be custom designed. So that the benefits:

Using XenServer reduces costs by:

- ❖ Consolidating multiple VMs onto physical servers
- ❖ Reducing the number of separate disk images that need to be managed
- ❖ Allowing for easy integration with existing networking and storage infrastructures

Using XenServer increases flexibility through:

- ❖ Allowing to time table 0 downtime maintenance with the aid of the use of XenMotion to live to migrate VMs among XenServer hosts
- ❖ Increasing availability of VMs by the usage of High Availability to configure policies that restart VMs on every other XenServer host if one fails
- ❖ Increasing portability of VM pix, as one VM picture will paintings on a number deployment infrastructures

There are two methods by which to administer XenServer: XenCenter and the XenServer Command-Line Interface (CLI).

- ❖ **XenCenter** is a graphical, Windows-primarily based person interface. XenCenter permits you to manipulate XenServer hosts, pools and shared storage, and to install, manipulate and monitor VMs from your Windows computing device machine.
- ❖ **XenServer Command-line Interface (CLI)** permits you to administer XenServer using the Linux-primarily based xe commands.

5.1.2 Platform layer:

The platform layer is the core part of non-public cloud control platform, and use OpenStack compute to finish cloud agency and deployment. Platform structure designs the control system and replicate device. Management device completes the management of the virtual system and the user.

Devstack project is to offer and preserve equipment used for the installation of the imperative openstack services from supply suitable for improvement and operational trying out. Devstack is an opinionated script to fast create some OpenStack improvement surroundings. It is likewise used to illustrate beginning and going for walks OpenStack offerings. Devstack has evolved to help a massive wide variety of configuration options and alternative structures

and assist services. Devstack is downloaded and established to utilize the OpenStack offerings.

Cloud Controller Node—Runs the Identity service, Image service, and dashboard and management portion to the computer: It also contains the associated Application programming interface services, MySQL databases, and messaging devices. *Compute Node* – Runs the hypervisor portion to compute virtual machine. Compute also provisions and operates tenant network and implement security groups. It can run more than one compute node. If there is more than two compute nodes, network service is needed.

Moreover, it is would be connected to the Service Repository module to integrate the OpenStack platform service with different services.

5.1.3 User Interface layer:

This layer is controls and managed by the ACGS hybrid Cloud, identifying the access model which could be an employee, customer, administrator, partners or others which can be created by the system's administrator. The authorization and identification process will be done using the Users Logs module to verify the entered information. Then it forwards the users' request to the appropriate component in the same layer. Furthermore, this layer has three other components: IaaS, PaaS, and SaaS. IaaS provides a resource from the Infrastructure layer. A middleware container is used to develop applications and give learners and educators the access to PaaS services provided by the PaaS component in the user Interface layer which provides an access to the Platform layer that contains the OpenStack platform. Lastly is the SaaS component which provides access to either the Platform layer so as to use one of the deploy applications or to public Clouds which may host an application used by system users, such as e-mail. There is a certain level of QoS which is granted by the provided SLA which includes detailed information about the services and available levels of resources to be accessed. This multi-layer in the ACGS hybrid Cloud architecture offers additional levels of security for the presented system.

5.1.4 Service Repository Module:

This consists of different services, accounting software, HRM system, SRP software, such as database systems, Web file system and so on. This module could contain specific details about services.

5.1.5 Users Logs module:

This is in particular liable for checking the song of the authorizations users and its get admission to mode which is selected within the User Interface layer. Users' statistics is stored within the Users Logs module, which include get right of entry to modes, user account call, password, user kind, and so forth. Moreover, this module manages and helps aid usage by way of recording the useful resource necessities and their popularity.

5.2 Experiment Setup

In the chapter one, the necessary tools are identified for designing and implementing the proposed architectural framework. This section describes to test our implemented prototype of the proposed architectural framework. Open source solutions are already driving innovation and capturing the cloud market, rapidly improve the proprietary software in cloud infrastructures. An open source XenServer with OpenStack meets the expectations of cloud builders for source code availability, open APIs and ecosystem contribution and integration. The detail installation steps explained in Appendix B.

The experimental steps through putting in the XenServer host software application on bodily servers, putting in XenCenter on Windows workstations and in the long run connecting them to form the infrastructure for developing and taking walks Virtual Machines (VMs). ASGS's non-public cloud will have the potential to be related to the public cloud at the height time. In addition, the person can request any wished service from the general public cloud at any time, which results in ACGS hybrid cloud.

A Xen host runs some of digital machines, VMs, or domains (the phrases are synonymous on Xen). One of these is in rate of going for walks the relaxation of the machine and is called area zero, or dom0. It is the primary area except after Xen and owns the storage and networking hardware, the device drivers, and the primary control software. Any different VM is unprivileged and is known as a domU or traveller. All client VMs are unprivileged, but you must observe that on XenServer (and different XenAPI using hypervisors), the OpenStack Compute issuer (nova-compute) additionally runs in a domU. This gives a level of protection isolation between the privileged gadget software and the OpenStack software program (a good buy of this is customer-going thru).

Our aim is to set up an experimental for demonstrate the developed prototype of private cloud using the open-source software Citrix XenServer/XenCenter and understand the tools and

services provided by OpenStack for deploying Infrastructure-as-a-Service cloud model. The different steps involving in OpenStack and Citrix XenServer/XenCenter are:

1. Assessing and establishing the IT Resources server.
2. Creating Virtual Machines (VMs) and configuring the virtualization layer.
3. Evaluation of performance of the proposed work

5.2.1 Citrix XenServer/XenCenter Installation

XenServer calls for at least separate physical x86 pc systems: one to be the XenServer host and the alternative to run the XenCenter utility. The XenServer host laptop is devoted honestly to the mission of jogging XenServer web hosting VMs and is not used for one-of-a-kind applications.

His laptop that runs XenCenter can be any large-motive Windows computer that satisfies the hardware necessities and may be used to run special programs.

System Requirements

Table 7: System requirements for the xenserver host

CPU	RAM	DISK SPACE	SYSTEM TYPE
One or more 64-bit x86 CPU(s), 1.5GHz minimum, 2 GHz or faster multicore CPU Recommended	2GB minimum, 4GB or more recommended	46GB of disk space minimum, 70GB of disk space recommended	Ubuntu server operating system

Table 8: System requirements for xencenter

Operating System	Windows 8.1, Windows 8, Windows 7 SP1, Windows Vista SP2, Windows Server 2012R2, Windows Server 2012, Windows Server 2008R2 SP1, Windows Server 2008 SP2
NET Framework	Version 4.5
CPU Speed	750MHz minimum, 1GHz or faster recommended
RAM	1GB minimum, 2GB or more recommended
Disk Space	100MB minimum
Network	100Mb or faster NIC
Screen Resolution	1024x768 pixels, minimum

The steps thru installing the XenServer host software on bodily servers, installing XenCenter on Windows workstations and ultimately connecting them to form the infrastructure for growing and strolling Virtual Machines (VMs).

The XenServer host consists of:

- ❖ The **Xen Hypervisor**: The hypervisor is the primary abstraction layer of software program. The hypervisor is responsible for low-level obligations which includes CPU scheduling and is answerable for reminiscence isolation for resident VMs. The hypervisor abstracts from the hardware for the VMs. The hypervisor has no information of networking, external garage devices.
- ❖ The **Control Domain**: Also called 'Domain0', or 'dom0', the Control Domain is a regular, privileged Linux VM that runs the XenServer management toolstack. Besides providing XenServer control features, the Control Domain moreover runs the purpose pressure stack that offers user-created Virtual Machines (VMs) get proper of entry to to bodily devices.
- ❖ The **control toolstack**: Also referred to as xapi, this software program toolstack controls VM lifecycle operations, host and VM networking, VM garage, man or woman authentication, and allows the manager of XenServer beneficial resource swimming swimming pools. Xapi presents the publicly documented XenAPI Management Interface that's utilized by all device that manipulates VMs and useful resource swimming swimming pools..
- ❖ VM templates, for putting in popular working structures as VMs.
- ❖ A neighborhood Storage Repository (SR) reserved for VMs.

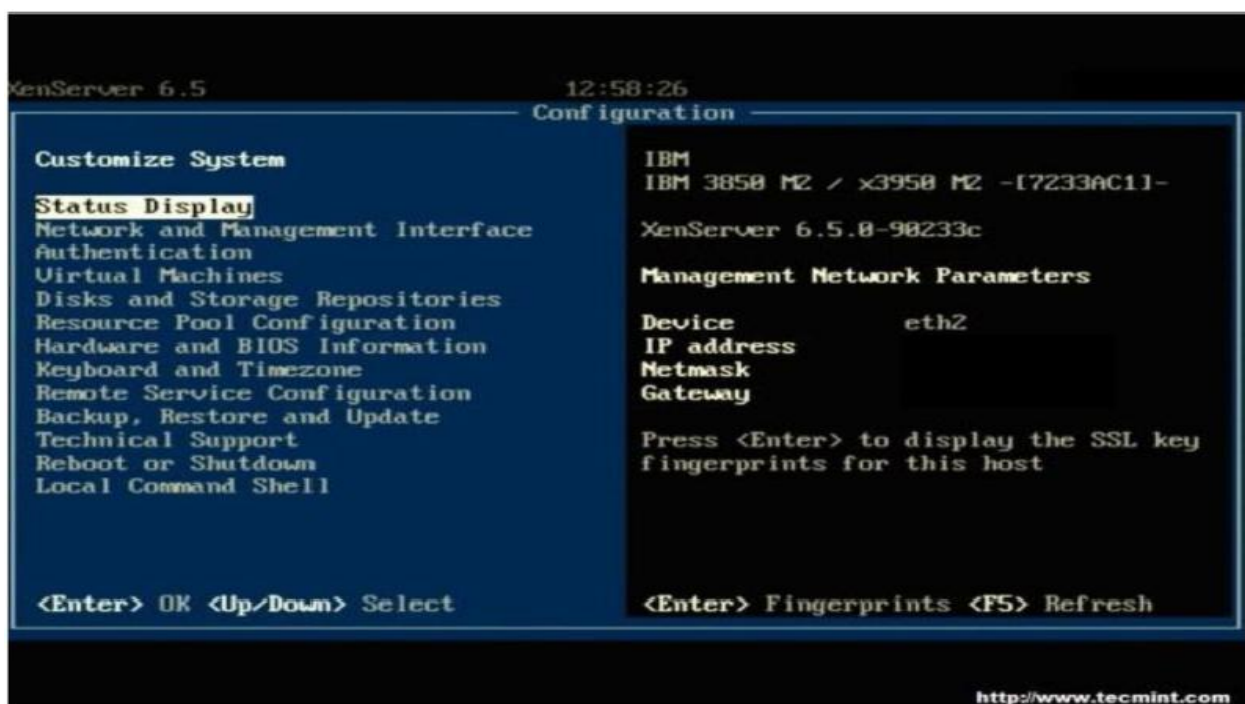


Figure 16: xenserver system details

5.2.2 Creating Virtual Machines (VMs) and configuring the virtualization layer

New virtual machines can be created either from operating system CD/DVD, ISO or existing templates provided by XenServer. When connected through XenCenter to the XenServer host templates are listed left side of the panel. Here a NFS server has been created to hold all necessary ISO required by an organization and that has been attached to pool. When a new virtual machine will be created all the desired ISO will be available; The VM creation process broadly consisting of allocating RAM, CPU and storage from NFS Share and then network interface for accessing the VM. After this VM will run and OS can be installed as like as a physical installation. After this according to requirement stacks will be created.

The XenServer 6.5 enables provisioning and re-provisioning of the shared pools of servers, storage, power, and network connectivity as needed, based on pre-defined templates. Typically, each template represents the complete infrastructure needed to host a specific application service, such as Windows XP, Windows 7, Windows 8, Windows Server 2008, or even a custom application such as MIS (Management Information System).A XenServer 6.5 administrator uses a graphical user management interface, XenCenter to build and publish these infrastructure service templates. Using XenCenter, users can view a catalog of published service templates and request an instance of a service to be automatically provisioned.

We can deploy a single XenServer 6.5 environment in place of multiple different server configurations to satisfy varied application requirements for CPU, memory, network, and storage and quickly build our private cloud. Physical Server resources are then available on demand as infrastructure services for IT users to request using a service catalog. An administrator can use the management console, XenCenter, to define pools of servers, network, and storage resources to support infrastructure services. Through the console, the administrator can also define virtual machine images and software deployment jobs, register user accounts, and assign resource pools to users.

5.2.3 Evaluation of performance of the proposed work

Open supply solutions are already using innovation and taking pictures the cloud marketplace, swiftly outpacing proprietary software program in cloud infrastructures. Underpinning the evolution of XenServer for cloud enablement changed into the circulates to make it completely open supply. An open source XenServer aligns with the OpenStack

Platform meets the expectancies of cloud builders for source code availability, open APIs and surroundings contribution and integration [16].

Performance testing techniques allow us to measure the cloud system performance accuracy. Performance is generally tied to an application's capabilities within the cloud infrastructure.

These were launching measured virtual machines with CPU per actual processor core. The study used Ubuntu 12.4 server image and launched the virtual machines with 1 CPU and 2GB of memory. Maximum memory consumption would have been 28GB leaving 4GB to the operating system and cloud software.

Measuring launch time was straightforward. We knew at what time we had started the process. We can say that Ubuntu server is running when we can log in with ssh. Ubuntu logs all the boot activity including launch of SSH daemon to /var/log/boot.log. All we had to do is to log in with ssh and take the timestamp of this file. The time difference gives us the needed launch time. Launch of single VM took less than two minutes.

Monitor metrics for all the virtual machines in XenServer pools automatically as new VMs are added and deleted. In the graphs that displayed below identify virtual machines CPU, memory usage, and network performance that gathered in host performance data under XenCenter performance tab.

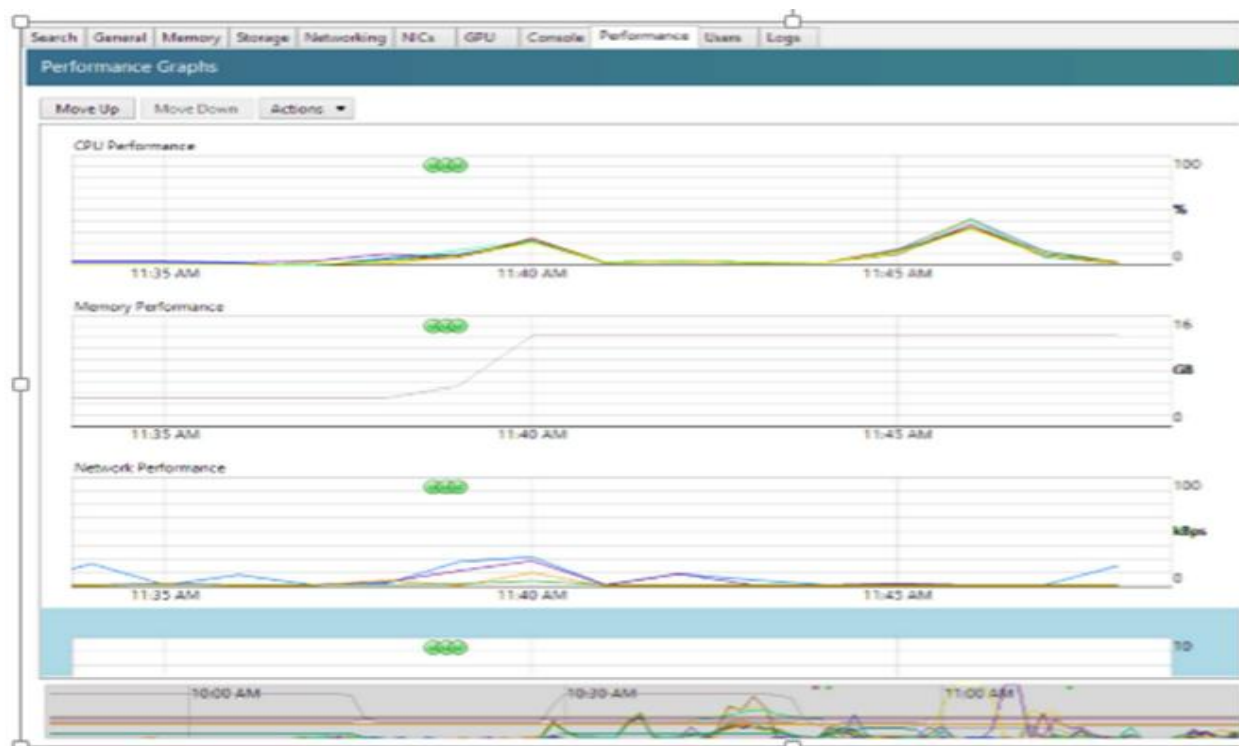


Figure 17: Performance graph

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study have presented the current status of ICT usage in Ethiopian Adama City Government Sector, limitations of the current ICT service delivery and identification of better ICT service delivery technologies has been studied.

The intent in the back of this studies observe became based on the identified problem of putting in complex ICT infrastructure in a traditional computing environment for reinforcing the productiveness and effectiveness of certain activities or functions made by means of ACGS because of either, financial issues, low infrastructure, criminal troubles or low IT expertise. Cloud computing promises to improve the reliability and scalability of IT structures; which allows ACGS to recognition their confined resources on their center commercial enterprise and approach.

Basically, the literature overview has been prepared in three sections. The first section covers essential concepts and traits of kinds of cloud computing. The second segment covers the usage of cloud computing in ACGS and explains its differing types. In the 3rd phase, empirical evidence at the situation remembers is mentioned in brief.

Cloud computing affords a option to these types of troubles by way of offering a wide variety of services that can cast off technological obstacles for ACGS inside the related to worldwide marketplace. A Cloud based framework has been supplied which combines the prevailing open resources to host distinct services. The proposed framework has been established by using interoperability and scalability contains all capabilities concerning the maximal wide variety of to be had resources which may be used concurrently from the cloud gadget.

The resulting framework allows collaboration between ACGS and assists newcomers into the market. The special components of the proposed framework offer effective abilities to cope with each offerings and sources control. This will offer superior stages of scalability, flexibility, and simplicity for management and transport of offerings in the clouds.

6.2 Recommendation

Although the consequences of this examine are hopeful, similarly work desires to be done to be able to understand the proposed framework to Ethiopian ACGS. The proposed framework have to be implemented on the selected area service and examined so that the proposed

framework will be changed primarily based on the feedback earlier than the framework's full implementation in all ACGS service provided.

Some pointers and destiny studies instructions are presented subsequent.

- ❖ Developing framework's for ACGS on improving the security structure of digital records centers in Cloud Environment for ACGS. Researchers may focus on providing safety within the cloud that protects the records in the Cloud Environment.
- ❖ Future research can carry out on exploring commercial enterprise models of cloud computing offerings for ACGS and their differences in keeping with business model ontology.
- ❖ Exploring the critical problems in choosing cloud provider companies, cloud-based service transport model, and cloud computing deployment version (Private & hybrid). In unique, it need to be analyzed with the aid of describing the strength and weak spot from service company to cloud-based totally carrier delivery and deployment model for ACGS more securing their facts.
- ❖ Adoption and usage problem that have been taken into consideration in this take a look at may be in addition studied extensive from multiple dimensions.

The suggestions made by this thesis were that other developing countries could also apply the developed framework to adapt or refine it based on their specific needs. Therefore, further research on the topic of interest is recommended. As the current transformation may not depend only on the adoption and use of technologies, but may also require a comprehensive approach that delivers fast, reliable, and accessible services, appropriate procedures and strategies should be established within the Adama, Ethiopian context; in other developing the circumstance should further be researched in accordance with the topic of interest.

6.3 Research Contribution

Each of the three phases of the interim theoretical framework development (see Figure 5-7) in this research study contributed towards answering the research questions and addressing the objectives of the research study. The findings provided practical and theoretical contributions, as presented below

6.3.1 Practical Contributions

A lack of academic study still limits the Cloud Computing, eGovernment services, and RCE sector in Adama; there is no such framework specifically developed for the Adama context. This study aims to explore components and develop Cloud Computing Framework for adama

City Government Sectors to facilitate eGovernment services in Adama. The framework consists of components of Cloud Computing, eGovernment services, and RCEs.

The final framework provides relevant information regarding the components that constitute a Cloud Computing framework for the Adama context for Cloud Computing for facilitating eGovernment services in RCEs. This framework has particular importance for the Adama government and for governments of other developing countries in the context of their own contexts.

The other practical contribution of this study includes the finding that, in this particular eGovernment services context, Cloud Computing technology is most appropriately placed as a tool to enhance service delivery and improve work activities. The study showed that the system (in Adama) was resistant to change; it illuminated current routine work practices and how these routines could remain resistant to change. In this way, the study contributed by providing a clear understanding of how Cloud Computing functionalities can improve existing systems for the delivery of eGovernment services and for improving work activities.

6.3.2 Theoretical Contributions

From the theoretical perspective, this research contributes to the theory and knowledge where eGovernment services are deployed. New knowledge also emerged about Cloud Computing in RCEs. It added value within the study of Cloud Computing by enhancing the development of e-governance that fosters service delivery and improves efficiency, effectiveness, and productivity of administrative tasks and improved the delivery of information and improved services to the public. Thus, the establishment of a conceptual base around WoredaNet Cloud Computing data centers will allow for responsive understandings of the research field. The results of the study thus laid the foundation for further studies and contributed to individuals, organizations, institutions, and government sectors in providing concepts, frameworks, theoretical models, and data for their research of the Cloud Computing field.

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APPENDICES

Appendix A: Cover Letter for Interviews

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF ELECTRICAL AND COMPUTING

DEPARTMENT OF COMPUTING

INTRODUCTORY LETTER

Dear Respondent

My name is Muktar Jeylan I am a student in the post graduate program specialization in Degree of masters of Science in Computer Science Engineering in Adama science and Technology University. I am conducting a search on the topic” A Cloud Computing Framework for Adama City Government Sector”. Cloud computing is a new technology concept that delivers IT services as computing utility through the Internet.

The aim of this research is to develop a Cloud Computing Framework that would assist ACGS to use and adopt for cloud-based services. In order to achieve the main objectives of this research and effectively address the research questions, we designed to collect primary data from various sectors of ACGS regarding ICT and related issue.

I would like to require to your kind cooperation to take a few minutes of your precious time to give an answer to the interview questions. Since the data is required for the academic purpose; only any information you share will be kept strictly confidential; thank you for your willingness to contribute towards on this research.

Thank you for responding to the questions

Muktar Jeylan

ADAMA, ETHIOPIA

Appendix B: Interview Questions

Please briefly explain your expectations about the following question

Section A: General Information

1. What is the current position that you hold in this sectors?
2. What Cluster does your sector belong to?
3. How many staff members are employed in your sector?

Section B: ICT Support in your Company

1. How can you are utilized ICT and for what purpose you use it?
2. Do you have challenges when you use ICT for your sector?
3. Do you think the current ICT services and supports that are provided are enough to achieve your business goal?

Section C: About Cloud Computing Questions

1. Have you try and tested any online IT services for your sector which may help you to perform better?
2. What do you understand about cloud computing technology?

Appendix C: Installing XenServer 6.5 and XenCenter 6.5

This section steps through installing XenServer [56] on a single bodily host, installing XenCenter on a Windows pc, and connecting them to form the infrastructure for developing and running digital machines (VMs). To get commenced, we need as a minimum two separate physical computer systems:

- ❖ XenServer host and
- ❖ A computing device computer to run the XenCenter utility.

The XenServer host computer is dedicated completely to the mission of taking walks XenServer hosting VMs and isn't used for other packages. The computer that runs XenCenter can be any stylish-motive Windows laptop that satisfies the hardware requirements and may be used to run different applications too.

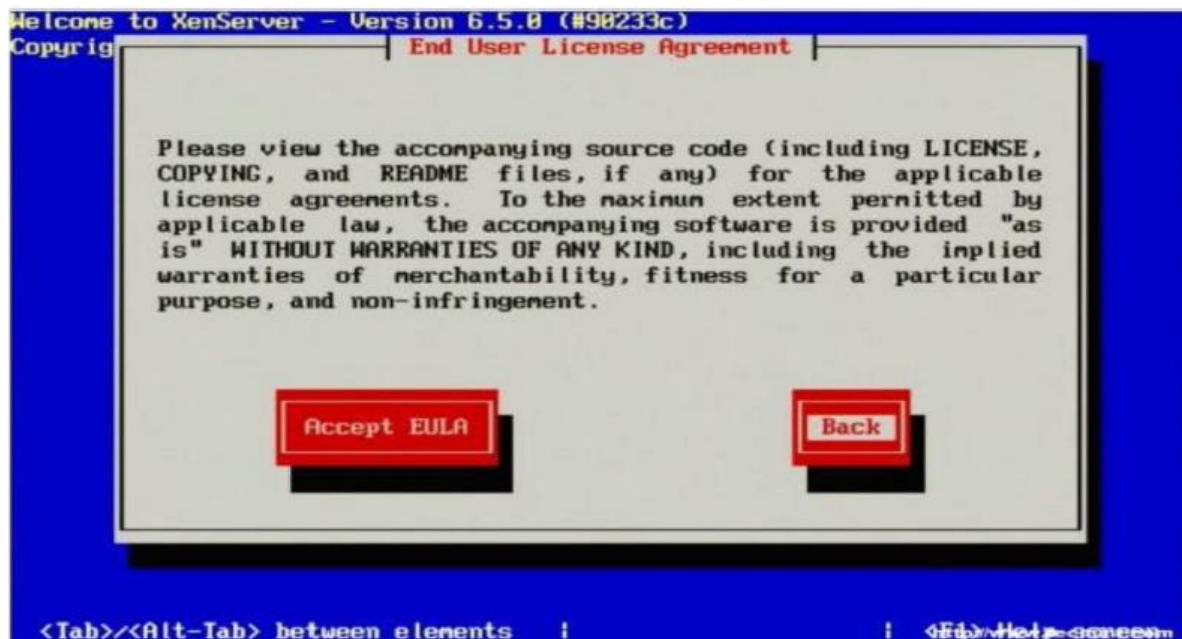
Install the XenServer 6.5

Steps:

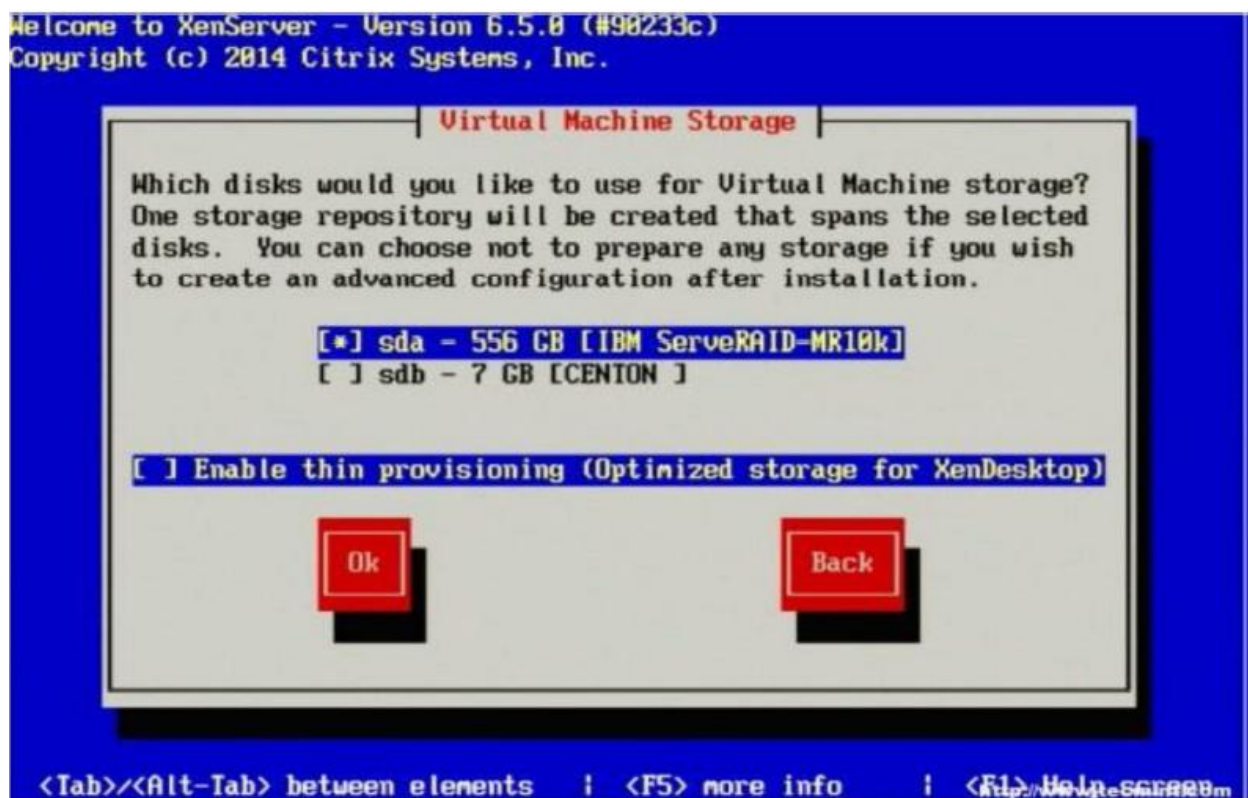
1. Insert the main installation CD into the DVD drive of the host computer.
2. Restart the host computer.
3. Boot from the DVD drive (if vital, see your hardware dealer documentation for data on converting the boot order).
4. Following the initial boot messages and the Welcome to XenServer display screen, select your keyboard format for the installation.



5. When the Welcome to XenServer Setup screen is displayed, select Ok.
6. Read and take delivery of the XenServer End User License Agreement (EULA).



7. If you have got multiple hard disks, pick a Primary Disk for the set up. Select Ok.
Choose which disk(s) you would really like to apply for digital machine garage.
Choose Ok.

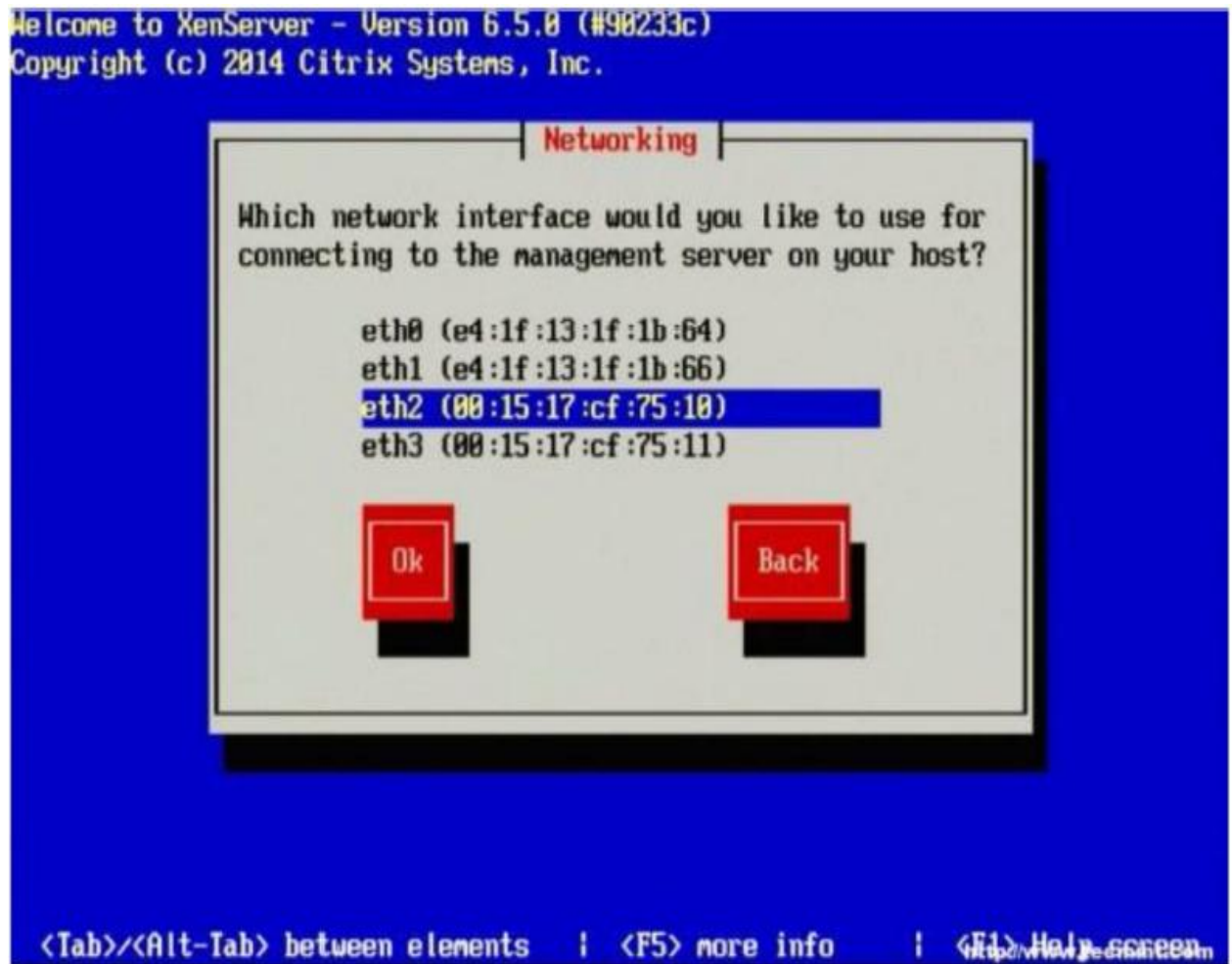


8. Select Local media as your installation source.

9. When asked about if you would really like to put in any supplemental packs, pick out No to continue.
10. Select Skip Verification, after which choose Ok.
11. Set and verify a root password, which the XenCenter utility will use to connect with the XenServer host.



12. Set up the management interface to be able to be used to connect to XenCenter. If your computer has multiple community interface cards (NICs), pick the NIC that you need to apply for management traffic (usually the primary NIC). A community port that isn't always tagged as a VLAN is required for the management interface.



13. Configure the Management NIC IP address with a static IP cope with or to use DHCP.
14. Specify the hostname and the DNS configuration, manually or automatically via DHCP. If manually configuring the DNS, enter the IP addresses of your number one (required), secondary (optionally available), and tertiary (optional) DNS servers inside the fields provided.
15. Select some time zone — the geographical place and then metropolis.
16. Specify how you would love the server to decide local time: the usage of NTP or guide time access. Choose Ok.
17. Select Install XenServer.
18. If you elected to set the date and time manually, you are prompted to achieve this.
19. From the Installation Complete display screen, eject the set up CD from the force, and then select Ok to reboot the server.



Installing XenCenter

The system necessities for XenCenter are nearby computer or pc with Operating System:
Windows 10, 8, 7, Windows XP, Windows Vista, Windows Server 2003, Windows Server 2008,

Windows Server 2008 R2 (all editions and versions)

.NET Framework: Version 3.5 or more

CPU Speed: 750 MHz minima, 1 GHz or quicker advocated

RAM: 1 GB minimal, 2 GB or more advocated

Disk Space: one hundred MB minimal

Network: 100Mb or faster NIC

❖ **Screen Resolution:** 1024x768 pixels, minimal.

To set up XenCenter;

1. Insert the primary set up CD into the DVD drive of the computer which you want to run XenCenter.
2. Open the patron deploy folder on the CD. Double-click XenCenter.Msi to start the installation.

3. Follow the Setup wizard, which permits you to adjust the default vacation spot folder and then to install XenCenter.
4. In the Server subject, enter the IP address of the host. Enter the basis username and password which you set for the duration of XenServer set up. Choose **Add**.



5. Finally, the following will be displayed

