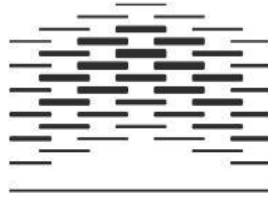TALLINNA ÜLIKOOL

OSLO AND AKERSHUS
UNIVERSITY COLLEGE
OF APPLIED SCIENCES

UNIVERSITÀ DEGLI STUDI DI PARMA

Education and Culture DG

ERASMUS MUNDUS

Prem Regmi

Similarities and Differences Between Cloud Service Vendors

Master thesis

International Master in Digital Library Learning

2015

Declaration

"I certify that all materials in this dissertation which is not my own work has been identified and that no material is included for which a degree has previously been conferred upon me."

November, 2015

....

Prem Regmi

Dedication

I dedicate this work to my father and my mother whose tireless efforts made me who I am today; and to my spouse and sister for their honest encouragement.

Acknowledgements

I would like to take this opportunity to write a note of acknowledgements to those who have assisted me in order to complete this study. I am indebted to my supervisor Professor Thomas Sødring for his guidance, advice and support throughout the research. He really enabled me to develop better understanding of the subject and truly helped for smooth progress of this thesis.

I would like to express my gratitude to Prof. Ragnar Nordlie and Prof. Nils Pharo for giving me a really good advice, cheer and continued support on the way during two years of study. Also I would like to thank the DILL scholars and visiting professors, I thank you all for conveying your knowledge and experience to me.

My sincere thanks to Kersti Ahrén Heløe and Terje Svardal, who have given a good support and advice on the way during my two years of study. I am thankful to all of my DILL classmates, it is my great pleasure to know and be your friend, and you have made these last two years a memorable experience in my life.

Last but not least, I would like to express my sincere gratefulness to my parents, my spouse, sister and many others who provided me supports directly or indirectly for completing this thesis and my master's study

Thank you all for your encouragement!

Abstract

The purpose of this study is to find out the Similarities and differences between different Cloud Service Vendors in terms of their fundamental technical aspects and range of service provided by them. This research has used a qualitative approach and content analysis for sampling of this study. With this study the readers can get insight of what cloud computing is, which are the different cloud service vendors and the offerings provided by them. With relative study between the cloud service vendors, users can get an insights and make a wise decision on choosing a reliable, secure and feature rich cloud service while choosing to acquire cloud services from the pool of several cloud service providers.

Keywords: Cloud, Cloud Computing, Cloud Services, Cloud Service vendors.

Table of Contents

List of Tables and Figures

SN	Table/Figure No.	Title	Page No.
1.	Table No.1	Cloud Service Vendors with comparisons	32-33
2.	Figure No.1	Cloud computing deployment and service models.	12
3.	Figure No. 2	Cloud Computing	13
4.	Figure No. 3	Cloud service architectures	17

List of Abbreviations

API	Application Programming Interface
CPU	Central Processing Unit
CRM	Customer Relationship Management
ER	Electronic Resources
GUI	Graphical User Interface
IaaS	Infrastructure as a Service
IBM	International Business Machine
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
NIST	US National Institute of Standards and Technology
OS	Operating System
PaaS	Platform as a Service
RAM	Random Access Memory
SaaS	Software as a Service
SLA	Service Level Agreement
VM	Virtual Machine

Chapter 1: Introduction

1. Introduction

This chapter is the introductory section of this research and it outlines the background and context of the study, followed by the statement of the problems, purpose and objectives, scope of the study, research questions, research methodology, limitations of the study, and finally the structure of this thesis.

1. 1 Background and context of the study

Information and Communication Technology (ICT) and Internet in particular have reached new era of advancement. Today a vast series of services has evolved over the internet. Among many different services available over the internet, Cloud is a very important as well as wide spread service in the world of technology today. A large crowd of individuals, firms, business, organizations and many other sectors has been highly influenced and rely on the services available in the cloud. And of course there are many vendors which provide services of different types through the cloud to their respective users.

Cloud Computing is considered as one of the emerging areas of computer science in recent times. It is providing very good facilities to business entrepreneurs by flexible infrastructure. It is the latest and highly demanded effort in delivering computing resources as a service. It represents a shift

away from computing as a product that is purchased, to computing as a service that is delivered to consumers over the internet from large-scale data centers – or 'clouds' (Ilango & Hosseini, 2010). Cloud computing has recently reached popularity and developed into a major trend in IT (Ilango & Hosseini, 2010).

Cloud computing is a way of leveraging the Internet to consume software or other IT services on demand. Users share form the vendors processing power, storage, bandwidth, memory and many different software as per the needs and requirements. With cloud computing, the resources are shared and so are the costs of the services. Users can pay as they go and only use what they need at any given time, keeping cost friendlier to them. Cloud computing is very much a business model as well. Providers of cloud computing solutions, whether they are software, hardware, platform, or storage providers, deliver their offerings over the Internet (Ahmed & Chowdhury & Ahmed & Rafee, 2012).

There has been much discussion in industry as to what cloud computing actually means. The term cloud computing seems to originate from computer network diagrams that represent the internet as a cloud. The US National Institute of Standards and Technology (NIST) has developed a working definition that covers the commonly agreed aspects of cloud computing. The NIST working definition summarizes cloud computing as:

a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage,

applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell, P. & Grance, T., 2009)

Cloud computing, at its simplest, is a collection of computing software, hardware resources and other services available from a decentralized network of servers. The term 'cloud' has long been used as a metaphor for the Internet.

Simple examples of cloud computing are Social networking sites, Web-based email clients like Yahoo, Gmail, Youtube, or Hotmail etc. You don't need software or a server to use them. Also, Wikipedia and even peer-to-peer networks like Skype or Bit Torrent are all applications that run in the cloud. All that a consumer would need is just an internet connection and you can start sending emails or use different other services. The server and email management software is all on the cloud (internet) and is totally managed by the cloud service provider Yahoo, Google, etc. The consumer gets to use the software alone and enjoy the benefits.

Cloud computing is a technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more inefficient computing by centralizing storage, memory, processing and bandwidth.

Cloud computing allows application software to be operated using internet-enabled devices. Clouds can be classified as public, private and hybrid. Cloud computing relies on sharing of resources to achieve coherence and economies of scale. At the foundation of cloud computing is the broader concept of converged infrastructure and shared services. Cloud resources are usually not only shared by multiple users but are also dynamically reallocated as and per demand.

The present availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of hardware virtualization, service-oriented architecture, and autonomic and utility computing have led to a growth in cloud computing.

Due to the unprecedented success of internet in last few years, computing resources is now more ubiquitously available. And it has enabled the realization of a new computing concept called 'Cloud Computing'. Cloud Computing environment requires the traditional service providers to have two different ways. These are infrastructure and service providers. Infrastructure providers manage cloud platforms and lease resources on the basis of usage. Service providers rent resources from infrastructure providers to serve the end users or the customers. Cloud Computing has attracted the giant companies like Google, Microsoft, and Amazon and it is considered as a great influence in today's Information Communication and Technology industry.

Although cloud computing has shown considerable opportunities to the IT industry in today's world, still there are number of challenges that requires to be addressed carefully. However, Cloud is, no doubt a highly emerging service model in the current world of technologies. There is huge number of service providers dedicatedly working in this domain. They are providing different categories of services to the customers with varied interest and service needs. So the major objective of my research will be to make a thorough study and analysis of service provided by different cloud service vendors and relatively analyzes them.

1.2 Statement of Problem

No doubt, cloud is a very highly emerging issue in the world of information technologies today. There are many different cloud service providers and millions of cloud service users. So the goal of this study is to identify the major similarities differences among different service providers and facilitate the end users to choose among the service providers in an easier way.

1.3 Purpose and objectives

Purpose

The purpose of this research/study is to identify the nature of services provided by different cloud service providers in the arena. As there are many different vendors of cloud services, it has been necessary to make a relative

study and significantly differentiate between the services they have been providing to the customers.

Objectives

The main objective of this research is to study about cloud services, the principle guiding the technology and the relative difference among cloud service providers. The objectives of the study can be highlighted as below:

1.   To examine the characteristics of the offerings of the various cloud vendors/providers.

2.   To examine if the offerings are comparable.

3.   To suggest a model for comparing the offerings.

1.4 Scope of the study

The scope of this research is limited to few Cloud Service Providers.

1.5 Research Question

To achieve the objectives of this research the following research question was framed:

I) To determine if the cloud offerings are comparable?

1.6 Research Methodology

Qualitative techniques will be used in this research to analyze data. I will

review earlier researches in the relevant topics and at the same time I will also study the conventions, documents and protocols developed by different cloud service vendors.

In the qualitative technique I will adapt Content Analysis as specific technique to analyze the data.

I will be looking at documents, text, or speech to see what themes emerge. What do people talk about the most? See how themes relate to each other. Find latent emphases, which is implicit or look at surface level - overt emphasis.

My data analysis will also be theory driven - theory determines what you look for. Rules are specified for data analysis. I will go through the conventions, manuals published by the cloud service vendors and other organizations working for/with cloud services.

1.7 Limitations of the study

There are some limitations in this study which could be considered as the factors influencing the objectives of this research.

First, the study was limited to some specific cloud service providers not each and every vendors across the huge mass of cloud service vendors present in the arena.

Secondly, qualitative technique is used in this study. This is a theory driven study and Content Analysis forms the basis of the study. However, there is

considerable amount of vendors' insights into the issues explored in this thesis.

Thirdly, the literature review covers only publications in English language.

Therefore, the findings are not necessarily generalized to all cloud service vendors providing different categories of services to different type of cloud service users.

1.8 Structure of the Thesis

This thesis consists of five chapters and it has followed the APA citation style throughout.

The first chapter, 'Chapter 1: Introduction' is a general introduction to this study and consists of background and context of study, statement of problem, purpose and objective of study, scope of study, research question, research methodology and limitations of this study.

The second chapter, 'Chapter 2: Literature Review' reviews the literature of previous researches relevant to this research work. This includes types of cloud, and different cloud services available over the internet. Also it presents quick summary notes of the popular vendors in the area of cloud service providers and historical information of some specific cloud service vendors.

The third chapter, 'Chapter 3: Research Design and Methodology' presents methodology used in this research process. It describes the data collection

method used in for this thesis, analysis method, research strategy employed, verification and validation method for this research and ethical considerations.

The fourth chapter, 'Chapter 4: Data Analysis' presents the data analysis method applied in this study and findings from the content analysis.

The fifth Chapter, 'Chapter 5: Discussion and Recommendation' presents a discussion of the research results, conclusions arrived at, recommendations and suggestions for further researches.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews documented literature on various works related to the research topic of this study. It starts with the discussion of relevant concepts needed to find answers to the research problem. The review is therefore aimed at gaining an insight on different cloud service vendors and relative differences among the service provided by them. The review of literature was done through literature search of both print and electronic materials on topics related to similarities and differences between cloud service vendors.

Due to the unprecedented success of internet in last few years, computing resources is now more ubiquitously available. And it has enabled the realization of a new computing concept called the Cloud Computing.

'Cloud Computing', a relatively recent term, has gradually build on decades of research in virtualization, distributed computing, utility computing, and more recently networking, web and software services. It implies a service oriented architecture, reduced information technology overhead for the end-user, great flexibility, reduced total cost of ownership, on-demand services and many other things of endeavor (Babu & Saikiran, 2013).

The term cloud became famous sometime in October 2007 when IBM and Google announced collaboration in that domain. This was followed by

IBM's announcement of the 'Blue Cloud' effort. Since then, everyone is talking about Cloud Computing (Rayport & Heyward, 2009).

Cloud computing is the next natural step in the evolution of on-demand information technology products and services. To a large extent, cloud computing will be based on virtualized resources.

Cloud computing is a paradigm shift in which computing is moved away from personal computers and even the individual enterprise applications to a cloud of computers. Cloud computing is where data and services reside in massively expandable data centers in the cloud and can be accessed from any devices connected to the internet. In cloud services users are given access to application software and databases (Rayport & Heyward, 2009). The cloud service offering companies manage the infrastructure and platforms on which the applications run. Software as a Service (SaaS) is sometimes referred to as 'on-demand software' and is usually priced on a 'pay-per-use' basis. Cloud Service Providers generally charge price to the end-users using a subscription fee.

The advancement of cloud computing is dramatically changing the horizon of information technology and ultimately turns the utility computing into a reality. However, it provides a large collection of benefits, but it also consists of many challenges in this domain including automatic resource positioning, energy management, and information security, and so on so forth. There are still so many issues to be explored. Opportunities are spread

in large scale in this arena for some ground-breaking contribution and bring significant development in the information technology industry.
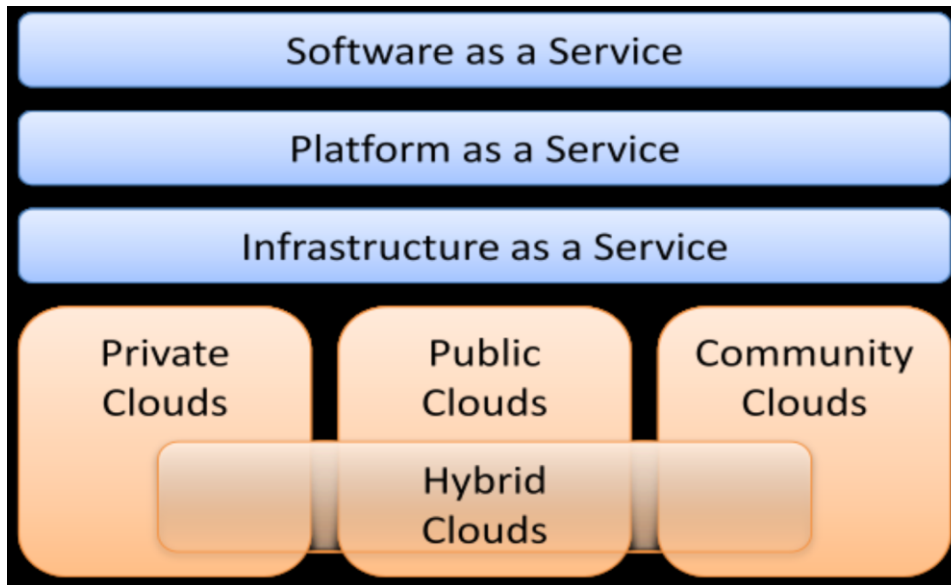
Fig. 1 : Cloud computing deployment and service models

The present availability of low-cost computers, high-capacity networks and storage devices as well as the widespread adoption of hardware virtualization, service-oriented architecture, and autonomic and utility computing has led to a growth in overall cloud computing technologies.

Cloud Computing environment requires the traditional service providers to have two different ways. These are infrastructure and service providers. Infrastructure providers manage cloud platforms and lease resources according to usage. Service providers rent resources from infrastructure providers to serve the end user or the customers. Cloud Computing has attracted huge companies like Google, Microsoft and Amazon and considered as a great influence in today's Information Technology industry.

A very large number of cloud computing vendors have risen that provides different services. The services provided depends on user needs and many fulfillment issues that rose to resolve their concerns, Service provided based on the kind of data and application for which the cloud is being used.
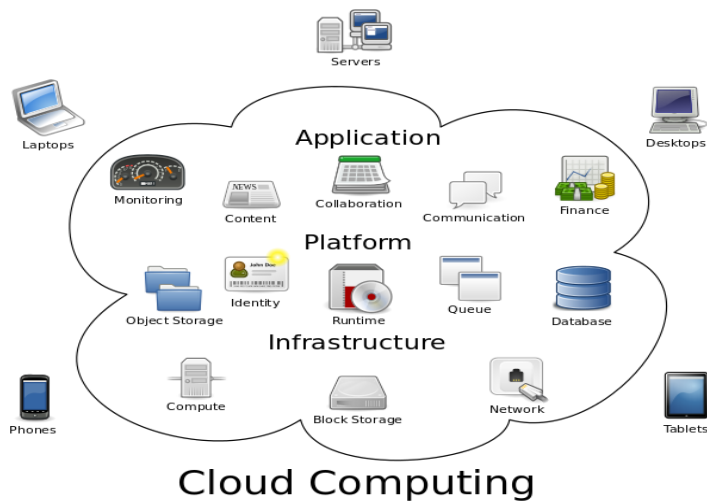
Fig. 2: Cloud Computing

Business owners are attracted to cloud computing concept because of several features. These are as follows:

- Lower start-up investment
- Easily to manageable
- Scalable
- Deployed faster
- Location independent
- Device independent
- Reliable
- Secure

Although cloud computing has shown considerable opportunities to the Information Technology industry of today's world, there are still a number of challenges that requires to be carefully addressed.

2.2 Types of Cloud

Cloud computing is typically classified on the basis of location of the cloud computing and type of services offered (Ahmed & Chowdhury & Ahmed & Rafee, 2012).

2.2.1 Location of the cloud

On the basis of location of cloud computing is typically classified in the following ways:

1. Public cloud: In Public cloud, the computing infrastructures are hosted by the cloud vendor at the vendor's premises. The customer has no visibility and control over where the computing infrastructure is hosted from. The computing infrastructure is shared between any organizations using the cloud service from the particular vendor.

2. Private cloud: The computing infrastructure is dedicated to a particular organization and not shared with other organizations. Some experts consider that private clouds are not real examples of cloud computing. Private clouds are more expensive as they are meant for some particular organizations.

2.2.2 Type of services offered

According to services, cloud vendors now compete for customers, cloud computing services can be divided into Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS), and so on so forth endeavor (Babu & Saikiran, 2013).

1. **Platform as a Service (PaaS) Providers**

   If there would be no presence of platform, there would be no applications and no need for cloud service infrastructures. Another is developers build and deploys their applications to the cloud. The goal is to be able to quickly and efficiently design and deploy applications, and make them function reliably.

   Some common PaaS providers are Microsoft's Azure, Google's Application Engine, Salesforce.com's force.com, etc.

2. **Infrastructure as a Service (IaaS) Providers**

   Infrastructure as a service (IaaS) providers serve up as a preliminary point for anyone looking to receive an IaaS cloud services. IaaS market has proven to be one of the most exciting ones in the cloud space, and there have been several important factors, such as changes in pricing strategies, pricing information, compatibility operating systems and languages, supporting services and many other have to be considered in order to choose particular

service provider. These could include some kind of storage services or virtual servers.

Top level vendors that provide Infrastructure as a service are Amazon S3, Rackspace Cloud Servers and Flexiscale.

3. Software as a Service (SaaS) Providers

SaaS is where cloud computing extends from infrastructure and platforms into business systems and user programs. From productivity applications and Customer Relationship Management(CRM) app's suites to software programs which manage cloud applications and deployment and even enable the creation of hybrid clouds. SaaS is exceptionally broad and runs the scope.

Here we consider cloud software and application providers that are performing in different ways, something new or something predominantly well. From traditional business scheme like Salesforce.com to superior analytics from Cloud9, whatever they are doing, they seem to be fine in doing that. The pioneer in this field has been Salesforce.coms offering in the online Customer Relationship Management (CRM) space. Other examples are online email providers like Google mail, i.e. gmail and Microsoft's hotmail, Google docs and Microsoft's online version of office called BPOS (Business Productivity Online Standard Suite).

A very large number of cloud computing providers have come in front that offer different services. The services provided depends on user needs and many fulfillment issues that are raised to resolve their problems or concerns, Service provided based on the kind of data and application for which the cloud is being used.
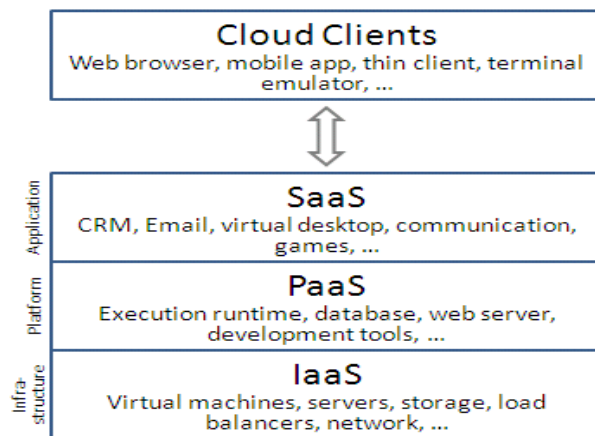
Fig. 3: Cloud service architectures

2.3 Popular Service Provider with Respective Services

2.3.1 Platform as a service (PaaS) Providers

Amazon's AWS, AppScale, Engine Yard, CA AppLogic, Force.com, Salesforce., GigaSpaces, Gizmox's Visual WebGui, google, GridGain's, long jump, Microsoft's cloud platform, Windows Azure, OS33, Out systems, RightScale, ThinkGrid, etc. forms a list of significant Platform as a Service (PaaS) providers.

2.3.2 Infrastructure as a Service (IaaS) Providers

Amazon Web Services, AT&T's, BlueLock, ENKI, Enomaly, GoGrid, HP, NaviSite, OpSource, Late last year, Savvis, etc. form a list of significant Infrastructure as a Service (IaaS) providers.

2.3.3 Software as a Service (SaaS) Providers

Cloud9, Apprenda, Akamai, Abiquo's CloudSwitch, CloudTran, Cumulux, FinancialForce, Pardot, Oracle's on demand, NetSuite, Salesforce.com, SAP Business ByDesign, etc. form a list of different SaaS service providers.

There are many vendors but we are considering some of service providers and analyzing them by viewing them in different dimensions. Providers like Salesforce, IBM, HP, RackSpace, AT&T Synaptic are considered for enhancing from different dimensions.

2.4 Cloud Service Vendors History

2.3.4.1 Saleforce

Salesforce.com was brought into motion on March,1999 by Oracle executive Dave Moellenhoff, Marc Benioff, Frank Dominguez, and Parker Harris as a company specializing in software as a service (SaaS). It's headquarter was located in San Francisco, California, with regional headquarters in Dublin, Singapore and Tokyo. Salesforce.com has translated services into 16 different languages and currently has 82,400 customers and over 2,100,000 subscribers. In

January of 2011, salesforce.com was documented as one of Fortune's 100 best companies to work for in 2011, receiving the 52nd position. Salesforce.com is best known for its Customer Relationship Management (CRM) products and, through acquisition, has expanded into the social enterprise area. Saleforce is a well-known and successful business because of its advanced CRM system.

Services Offered by Salesforce

Salesforce provides services like Sales cloud, service cloud, and social chatter.

2.3.4.2 RackSpace

RackSpace is one of the Information Technolofy (IT) hosting companies located in San Antonio, Texas, USA. Their data centers present service in Illinois, Virginia, the United Kingdom (UK), Australia, Texas, and Hong Kong.

In the years 2011 & 2013, the company has taken place in one of the top 100 place, work by Fortune Magazine. Rackspace, although the initiator began as application developers for end-users, they founded that most of the companies did not know the process to host their applications, or would not like to involve in hosting. The originator needs to focus on app's development but not in hosting but they were incapable to find a way for opportunity to outsource the hosting task.

Business model in RackSpace

Rackspace has two service level divisions: Managed and Intensive. These both service levels obtain support through live chat, telephone, ticket system, and e-mail, but they are intended to serve the needs of different businesses. The Managed support level contains 'on demand' support where proactive services are provided, but the customer can contact Rackspace when they are in need of additional supports. The Intensive support level consists of 'proactive' support where numerous proactive services are provided, and customers receive other consultations about server configuration to them. Extremely customized implementations generally come under this category of support.

On Oct 2006, Mosso Inc. was launched, which experimented with white-labeling hosting services. This division is groundwork for Rackspace's present Cloud Computing offering. In 2008 Oct 22, Rackspace declared that it attained Slicehost, virtual servers provider and Jungle Disk, provider for online backup software and services.

Rackspace announced that it consists of process to implement OpenStack Computing as the basic technology for their Cloud Servers product in April 2012. With this changed a new control panel in addition to that add-on cloud services providing server monitoring, block storage, databases and virtual networking.

2.3.4.3 IBM (International Business Machines)

IBM cloud structure starts with the physical hardware of cloud. IBM proposes three hardware platforms for cloud computing. The provided platforms gives built in support for virtualization. Next following layer of the IBM framework is virtualization. IBM has involved with virtualization over forty years and suggest IBM Websphere. IBM cloud technologies come into view from the combination of two of IBM's leading technologies: Mainframes and Virtualization. In 1960s IBM's first experiments in virtualization with development of virtual machine (VM) IBM first began to develop a clear strategy for cloud computing in 2007, stating its mission to build clouds for enterprise clients and provide services to fill gaps in existing cloud environments. Since 2011, adoption of IBM SmartCloud solutions has increased rapidly. Also the software and services are utilized by more than 20 million end-user customers from throughout the world. Some of their clients include American Airlines, and 7-Eleven, CARFAX, Aviva Frito-Lay, and so on so forth.

Cloud Services offered by IBM

- **Design and Build**

Design a Cloud, Build a cloud, Migrate to cloud are the different cloud services offered by IBM for design and build.

Designing and building a cloud background can be off putting task.

You need to be confident that you have selected the best delivery model and workloads to migrate to the cloud. The cloud implementation may take a major dedication of time and resources. IBM's cloud professional helps you to gather speed your adoption of cloud.

- **Secure and Manage**

Secure your cloud, Manage your IT security with cloud, Manage your infrastructure, etc. are the different cloud services offered by IBM for secure and manage.

We need to manage the health, performance and security of data center. With cloud-based services from IBM, you can reduce the complexity and cost of managing multiple security devices and technologies. And you can access robust IBM software over the cloud to control your IT infrastructure or optimize your service desk support. If you have already implemented a cloud environment, IBM can also help you gain insight into the security strengths and vulnerabilities of your cloud environment. IBM is accepted as global organizer in end-to-end IT security solutions and software as a service offerings.

- **Store and Virtualize**

Store your data in the cloud, Virtualize your infrastructure with cloud are the different cloud services offered by IBM for store and

virtualization.

Access solutions from IBM enterprise-class virtual infrastructure for cloud-based storage, desktop and Infrastructure as a service (IaaS). Built with help of IBM architectures, management tools and resource toughened many customer cloud activities and IBM's internal cloud implementations in order to meet lower capital and operational costs in project and for scalability and security. The storage and virtualization solutions are designed.

- **Recovery**

Back up and recover your business data are the different cloud services provided by IBM for recovery.

Cloud technology can be helpful faster and cost-effective recovery in the occurrence of a distraction, data loss or a tragedy. IBM provides a collection of solutions that includes backup services, server recovery and data protection for helping you to supervise risk, lessen costs and meet narrow observance authorization. With added 40+ years of experience in business spirit and information security and resiliency centers over the world, IBM provides solutions for on-site, off-site and hybrid cloud-based data protection.

2.3.4.4 AT&T Synaptic

The history of AT&T dates back to the invention of the telephone itself. The

Bell Telephone Company was established in 1879 by Alexander Graham Bell, the inventor of the telephone. Bell also established American Telephone and Telegraph Company in 1885, which acquired the Bell Telephone Company and became the primary phone company in the United States. This company maintained a monopoly on telephone service in the United States until anti-trust regulators split the company in 1982. One of these resulting companies, Southwestern Bell, later purchased the original AT&T and took the AT&T name in 2005 - this is the company known as AT&T today.

why you need AT&T Platform as a Service: A complete development environment to build and launch custom applications quickly, run them reliably and manage them easily across the full application lifecycle. As an AT&T Cloud Service, AT&T Platform as a Service can also deliver the high performance you need and the low per-user price you want. AT&T Platform as a Service provides cloud-based, self-service tools:

- Sign up for AT&T Platform as a Service online

- Provision the virtual resources you need

- Create a development environment within minutes

- Avoid long procurement cycles

- Reduce capital equipment expenses

- Speed development with 50 pre-loaded, customizable templates

- Build applications without writing a single line of code

- Quickly automate, change and support a wide range of business processes

- Enable non-traditional developers to build applications

Chapter 3:

Research Design and Methodology

3.1 Introduction

This chapter- Research Design and Methodology, discusses how the study was conducted and the method used to answer the research questions. It specifically explains the data collection methods, and how data analysis techniques were used. In addition, ethical considerations and research limitations are also covered in this chapter.

3.2 Type of research: Qualitative approach

In research design, different methods are adapted, most basically- qualitative research method and quantitative research method. In one of his papers (Marvsti, 2004) stated that "on the most basic level, *quantitative research* involves the use of methodological techniques that represent the human experience in numerical categories, sometimes referred to as statistics. On the contrary, *qualitative research* provides detailed description and analysis of the quality, or the substance, of the human experience".

This research has adapted Qualitative research methods, in particular content analysis. Content analysis is a method for summarizing any form of content by counting various aspects of the content. This enables a more objective evaluation than comparing content based on the impressions of a listener.

In qualitative researches, researchers will have a chance to interpret and find out meanings from the collected data. In addition, this qualitative approach was taken because the objectives and the research questions in this study is better addressed by this particular research method. Qualitative research will allow much broadly answers to stated objectives of this research and may give valuable insights which might have been missed by any other method.

Therefore, in order to know the differences between the different cloud service vendors a qualitative research approach was initiated in this research.

3.3 Research strategy: Content Analysis

In this research, content analysis is chosen as the research strategy. Researchers regard content analysis as a flexible method for analyzing text data (Cavanagh, 1997). Content analysis describes a family of analytic approaches ranging from impressionistic, intuitive, interpretive analyses to systematic, strict textual analyses (Rosengren, 1981). The specific type of content analysis approach chosen by a researcher varies with the theoretical and substantive interests of the researcher and the problem being studied (Weber, 1990). Although this flexibility has made content analysis useful for a variety of researchers, the lack of a firm definition and procedures has potentially limited the application of content analysis (Tesch, 1990).

A qualitative content analysis research strategy is believed to be more appropriate in this study to investigate the similarities and differences

between cloud service vendors as this study was focused on making relative study between different cloud service vendors.

3.4 Data Collection Method

Research methodologies are the tools for data collection. (Denscombe, 2010) pointed that "there are four main methods that social researchers can use: questionnaires, interviews, observation and documents". These are type of equipment that allows relevant data to be collected. In practice, certain methods tend to be associated with certain strategies.

For instance, the use of an observation and document study is often linked with the use of content analysis as the method for data collection. This is because the strategy and the method tend to work well together.

This research used content analysis method because it aimed to understand the contents and facts that has been understood and established over the time in the relevant topic and subject.

3.5 Data processing and analysis

The process of data analysis involves preparing the data for analysis, moving deeper and deeper into understanding the data, representing the data, and making an interpretation of the larger meaning of the data. The method for analyzing data was content analysis.

Content analysis is a method for summarizing any form of content by counting various aspects of the content. This enables a more objective evaluation than comparing content based on the impressions of a listener.

The object of qualitative content analysis can be all sort of recorded communication (transcripts of interviews, discourses, protocols of observations, video tapes, documents ...). Content analysis analyzes not only the manifest content of the material as its name may suggest. (Becker & Lissmann , 1973) have differentiated levels of content: themes and main ideas of the text as primary content; context information as latent content. The analysis of formal aspects of the material belongs to its aims as well. Content analysis embeds the text into a model of communication within which it defines the aims of analysis. This is expressed by Krippendorff, who defines "content analysis as the use of replicable and valid method for making specific inferences from text to other states or properties of its source" (Krippendorff, 1969).

Qualitative content analysis defines itself within this framework as an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step by step models, without rash quantification.

Ethical considerations

The main ethical considerations in this research were connected with review of earlier work in the similar domain. The researcher has tried his level best to give proper citation of the original sources.

3.6 Verification and validity of data

Validity and reliability is an important key to effective research. (Patton, 2002) stated that "validity and reliability are two factors which any qualitative researcher should be concerned about while designing a study, analyzing results and judging the quality of the study".

In this research for verification purpose, the researcher revisited the entire collection of data from various secondary sources as many times as possible to cross-check and to verify the evolving ideas. In order to achieve reliability many different sources were taken into account and studied thoroughly.

3.7 Limitations of the Research

In addition to the limitations that were mentioned in the first chapter, i.e. chapter 1, there are certain limitations related to the collection of data and interpretation of data and amount of data. In this research the secondary data were collected from various sources including print media and online resources. The sample used for this study was relatively small. This was mainly because there are numerous cloud service vendors and it was difficult to include all of them due to time constraints of the Master thesis project.

Chapter 4: Data Analysis

4.1 Introduction

In examining the similarities and differences between the cloud service vendors, different secondary sources both printed and electronic media were taken reference of. This chapter- data analysis attempts to describe and analyze the data gathered through secondary resources and provides explanations of the findings in light of the previous research findings.

4.2 Comparative study of Cloud Service Vendors

For the purpose of this study different cloud service vendors were taken into consideration and a relative study was made between them. For this study, Salesforce, IBM, Rackspace and AT and T were taken as samples. And with these different cloud service vendors, different dimensions were sorted out to compare the service between them. Some of the dimensions include: Supporting Services, Compatibility, Security, Pricing Information, User Interface and other additional features.

For the ease of study, the different parameters that were considered for making relative study between the cloud service vendors are presented in tabular form as presented below. And parameters has been marked 'Y' for the availability of service and 'N' for the unavailability.

A brief analysis of the data has been done after the table.

Domain Considered			Salesforce	IBM	HP	Rackspace	AT and T
Supporting Services	Service Categories		PaaS, SaaS	IaaS	IaaS	IaaS	PaaS
	Free Support		Y	Y	Y	Y	Y
	Phone		Y	Y	N	Y	N
	Urgent response		Y(24/7)	N	Y(24/7)	Y(24/7)	Y(24/7)
Compatibility	Language support	Java	Y	N	Y	(Root server access)	N
		Php	Y	N	N		N
		Python	N	N	N		N
		Sql	Y	N	Y		N
	OS Support	Linux	Y	N	N	N	Y
		Windows	Y	Y	N	N	Y
Security	Email/password Security		Y	N	N	N	N
	Backup storage		Y	N	N	N	N
	Critical Data Privacy		Y	Y	N	Y	Y
	Firewall		Y	N	N	N	N
Pricing Information	Base plan		One month free edition, with 1 GB of storage.	One Virtual 32 bit CPU with 1.25GHz 2 Gb Virtual memory. , 60GB Instance	Pay as you go on subscriptio n	256 MB RAM, 10GB local storage, 10 Mbps Network	Pay-as-you-go each month. data access type and

			storage		throughput	storage policy
User Interface	Web Based Control Panel	Y	Y	Y	Y	Y
	API	Y	Y	Y	Y	Y
	Command Line Interface	N	N	N	N	N
	GUI	N	N	N	N	Y
Additional Features	View/Edit Files	Y	N	Y	Y	Y
	File Hosting Service	N	Y	Y	Y	Y
	Monitoring	Y	Y	N	N	Y
	Free Support	N	Y	N	Y	Y
	Virtual Private Server	N	N	N	Y	N
	Auto Scaling					

Table 1: Cloud Service Vendors with comparisons

4.3 Data Analysis

Cloud service vendors were compared and analyzed for different service criteria. And depending on the level of different services offered and evaluation of those facilities/services various assumptions could be made.

4.3.1 Cost Reductions and Service Optimizations

The more varieties of plans are offered the better is the service considered, e.g. hourly, daily, monthly and yearly package plans. The plans are also directly influenced by the cost of the service associated. The average cost for a month, cost of out-bound data transfer, cost of inbound data transfer, storage, etc. count for the optimization of cloud services.

4.3.2 Scalability and Automation

Scalability refers to the capability of a system, network, or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth. A cloud service is expected to be scalable to adapt with growing technologies.

Use of APIs enhances the use of cloud services. Whether or not a company provides API service counts a lot. If the company offers APIs to interact with the servers, the vendors are highly regarded. Along with the scalable service and products, the service needs to be automated too and it needs to be monitored. The monitoring can be poor, average or extensive. The better the monitoring options, the better are the cloud service vendors regarded. Companies that have no monitoring/alert solutions integrated, requiring the deployment of third-party tools or that extra services be purchased are leveled poor while the companies with very simple integrated monitoring tools are regarded as average and companies with very complete integrated monitoring tools offered for no additional cost are leveled extensive.

4.3.3 Flexibility

The number of different available instance types, in terms of RAM, CPU, disks and the number of different supported operating systems available as pre-configured images determine the evaluation criteria for cloud service vendors. The more flexible the cloud services, the more the service are desirable.

4.4 User Concerns for Analyzing Cloud Service Vendors

4.4.1 Security Features

Security is the prime concern associated with the users of different cloud services. If the vendors offer the possibility of protecting servers with firewalls and other security functionality, users are more attracted towards them. Extensive security services are highly preferred with the cloud service vendors. Companies that offer not only several security features, but also some security automation are regarded extensive. Companies that offer a more advanced mix of security features are regarded average. While companies that only offer the most basic security features (such as a basic firewall), or no features at all are regarded poor.

4.4.2 Ease of Migration

Users sometimes tend to shift from one cloud service vendor to another for several reasons. And at such times, easy migration

facilities are required. If the vendor employs or supports open standards in cloud infrastructure, the services can be easily migrated.

4.4.3 Reliability

Reliability is the prime issue concerned with any services and for the cloud services as well. Cloud service users often look for service age, i.e. how long the service has been around; Service Level Agreement (SLA) - The uptime SLA offered regardless of past performance, in percentage points and support - A3 level extensive subjective scale.

Chapter 5:

Discussion and Recommendations

5.1 Introduction

The main purpose of this study, as stated in the first chapter is to investigate the similarities and differences between different cloud service vendors. This research used qualitative methods to collect the relevant data. Content analysis was performed to gather qualitative data. This chapter integrates the analysis of the data as presented in Chapter 4. Then the chapter discusses some of the similarities and differences between the cloud service vendors. It also discusses the findings related to the research questions of this study. Then it provides some recommendations based on the findings of this study and concludes by implications for further research.

5.2 Discussion and Finding

The research was undertaken to find the answer to the research questions: if the cloud offerings are comparable?

And of course the cloud service vendors can be compared among themselves in terms of various criteria.

One of the criteria could be support service provided by the cloud service vendors. There are many cloud service vendors in the market and it is obvious for the customers to seek the vendors with high range of support

services offered to them with in the budget constraints. The more the services are provided by the vendors, the more they could be preferred by customers. The support services provided by the cloud service vendors over the various categories of services like PaaS, SaaS, IaaS could be online support, phone support and urgent response. If these services are fully available and that too 24/7, that is the highly appreciable. In fact, support is a very essential thing considered by the customers and should be borne seriously by the vendors.

Another criterion, that the cloud service vendors could be compared among themselves is in terms of compatibility. Different customers may be using different operating systems and they may opt for various programming language platforms. So, the cloud service vendors should strictly consider the issues related to compatibility. The more platforms and programming language that a cloud service vendors support and the more operating systems that it can be moved through, the cloud service vendor can e considered more suitable. Cloud service vendors can be compared among themselves on the basis of level of compatibility.

Next, comparing criterion, and of course a highly regarded criterion is security. Security is a very important as well as sensitive issue. Every customer that they would first question about is the security feature associated with the cloud service vendors. If the cloud service vendors are providing better security features together with the service packages, the customers are more likely to use their services on the other hand. if the

security services are weak then obviously, the customers will go for next options. In security different things can be taken account of, for an example email and password security, data security, data backup, privacy, firewall, etc. These are the most essential security features and should maintained at the minimum level by any of the cloud service vendors for better sense of reliability among their prospective users/customers.

Pricing information is a very important criterion for comparing among the various cloud service vendors. In addition to the security, compatibility and range of service provided, pricing information is also an important issue considered by the customers. Mostly, general users/ customers of cloud services would like to be economic with the cloud service they are using. So clouds service vendors can often be ranked by the customers on the basis of the pricing information they have and variety of economic service packages they offer.

These days users want access and control of their account and services as much as possible and that too with easier ways. So, graphical user interface has a lot to do for the cloud service vendors. The vendors who provide more GUI features are preferred over traditional ones. Web based account control mechanisms are preferred even more. Some vendors provide command line control and API features too. Expert users find it reliable to access their services through the command line. So depending on the level of GUI facilities provided by the cloud service vendors they can be compared accordingly.

The criteria we discussed above are the common features. In addition to these features, some more extra advanced features which are provided by the cloud service vendors. These extra features provide extra privilege and facilities to the cloud service users. The additional features include features of adding and editing files in the server, file hosting services, monitoring facilities, virtual private server and auto scaling facilities as per the essence and demand. These extra features further promote the cloud service vendors and urge users to get their services. The more the additional features are available the more are the cloud service users probable to get the service from such vendors.

These different features or services available with the cloud service vendors makes the foundation for comparing them. It is not the case that a particular vendor has only one of those services or all of the services available with them. So the cloud service vendors could be similar to each other or different form others on the basis of availability of those services and extra features.

In this study the researcher found some similarities and differences among various cloud service vendors.

The similarities are that the cloud service vendors offer services similar to each other viz. supporting services like different categories of services like PaaS, SaaS, SaaS, IaaS, etc. For these different categories of services the vendors facilitate online support, phone support and urgent supports. Together with these different categories of services, the vendors also

facilitate with different programming languages and operating systems, storage and on demand services, security of different levels ranging from free services to paid services and additional features like file manipulation options, user friendly GUI and many others additional features to count.

The major differences are on the way they provide services to the customers and the reliability of those services. Some vendors offer several services and with high customer care and huge categories of service packages.

Some vendors offer highly flexible, scalable and optimizable and automated services while others are average or poor to these regards.

5.3 Recommendations

The main objective of this research/study was to find out the characteristics of various cloud service vendors, if the cloud service providers are comparable and to suggest the model for comparing the cloud services.

Below is a brief discussion of the findings related to these research questions.

The cloud service providers are characterized by various aspects like Support Services, Compatibility, Security, Pricing, User interface and advanced features.

And based on these various features, the cloud service providers can be compared among each other for cost reductions and service optimizations, scalability and automation, migration and security options offered.

Depending on the level of service provided for these several options poor, average or extensive, relative study can be made between various cloud service vendors. The better the position of cloud service vendors in regards to the abovementioned criteria, the more reliable is the cloud service vendor is and we can take their services with higher confidence.

5.4 Implications for further research

There are many possible implications for further study with regards to this study. Of course there are hundreds and thousands of cloud service providers offering several categories of services to their corresponding customers. And there are several similarities and significant difference between them as regards to the reliability and quality of service provided by them.

So, similar other research can be conducted to compare the cloud service vendors in terms of range of service offered by them and the level of reliability of service offered by them.

5.5 Conclusion

Cloud is an emerging subject in the world of Information technologies in the recent world of technologies. There are different types of cloud services available to the end-users which could be individuals, firms, organizations or any other larger enterprises. And to cater these services, there are many vendors/ service providers. The end-users get the cloud services through these different vendors. There are many similarities and difference among those cloud service vendors in terms of different categories of services

offered and the level of reliability, security, extended features,operating system and platform support and user friendless in using those services.

As there are many vendors/providers of cloud services, like Salesforce, IBM, RackSpace, AT&T Synaptic are considered for enhancing from different dimensions. As a Service market, however, to prove one of the most promising ones in the cloud vendors arena, and there have been several important factors, such as changes in Pricing strategies, Compatibility, Operating Systems and programming languages supports, supporting services and the entrance of some technological advancements and heavy weights.

This research attempted to make a general comparison of cloud service providers, to serve as a starting point for anyone looking to take the throw into relative study of cloud computing. Problem and limitations of the study present a number of new research opportunities in cloud computing to sadvance the technological aspects of cloud computing, and highlight the resulting directions of research in Future.

References:

Ahmed,Mohiuddin , & Chowdhury, Abu Sina Md. Raju, & Ahmed, Mustaq, &Rafee, Md. Mahmudul Hasan. (2012). An Advanced Survey on Cloud   Computing and   State-of-the-art Research Issues. IJCSI International   Journal   of Computer Science.   Vol. 9 (Issue 1, No 1), 1, Retrived   August 15, 2015 from www.IJCSI.org

Babu, J.Jagadeesh , & Saikiran, P. (2013). Evaluating Cloud Service Vendors with Comparison, International Journal of Advanced Research in Computer Science and Software Engineering. Vol. 3 (Issue 5).

Becker, J. & Lißmann, H.-J. (1973). Content analysis - review of social science methodology. Working Papers on political sociology 5. Munich: Olzog.

Cavanagh, S. (1997). Content analysis: concepts, methods and applications.   *Nurse Researcher*, 4 (3), 5-16.

Ilango, Sriram & Ali Khajeh, Hosseini. (2010). Research Agenda in Cloud Technologies,   Retrived   August   10,   2015   from http://arxiv.org/abs/1001.3259

Krippendorff, K. (1969). Models of messages: three prototypes. In G. Gerbner, O.R. Holsti, K. Krippendorff, G.J. Paisly & Ph.J. Stone (Eds.), *The analysis of communication content*. New York: Wiley.

Marvasti, A. B. (2004). *Qualitative research in sociology: an introduction*. London: Sage.

Mell, P. & Grance, T.(2009). Draft NIST Working Definition of Cloud   Computing.

Ohlman, B., Eriksson, A. and Rembarz, R. (2009). What Networking of Information Can Do for Cloud Computing. In Enabling Technologies

Patton, M. Q. (2002). *Qualitative evaluation and research methods.* (3rd ed).   Thousand Oaks, CA: Sage.

Rosengren, K. E. (1981). Advances in Scandinavia content analysis: An introduction. In K. E. Rosengren (Ed.), *Advances in content analysis* (pp. 9-19). Beverly Hills, CA: Sage.

Rayport, J.F. and Heyward, A.2009. *Envisioning the Cloud: The Next Computing Paradigm*. Marketspace.

Weber, R. P. (1990). Basic content analysis. Beverly Hills, CA: Sage.

www.**ibm**.com/**cloud**-computing *retrived August, 2015.*

www.thecloudtutorial.com/cloudtypes.html *retrived August, 2015.*

www.redbooks.ibm.com/redpapers/pdfs/redp4396.pdf *retrived September, 2015.*

www.tud.ttu.ee/material/enn/IDU0080_2010/Loeng14Clouds/25556612-Salesforce-Getting- Started- Guide.pdf *retrived October, 2015.*

www.en.wikipedia.org/wiki/Cloud_computing *retrived July, 2015.*

www.wikinvest.com/concept/Cloud_Computingwww.nist.gov/itl/csd/cloud-102511.cfm *retrived August, 2015.*

www.thecloudtutorial.com/related.html *retrived July, 2015.*

www.thecloudtutorial.com/cloudtypes.html *retrived July, 2015.*