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Cloud Security in 21st Century: Current Key Issues in Service Models on Cloud Computing and how to overcome them

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Executive Summary

Cloud computing is a disruptive innovation which offers new ways to increase capacity and capabilities of the organization's IT infrastructure. In last few years cloud computing has taken computing industry by storm and many organizations are using cloud computing services to increase the efficiency, decrease their IT budgets and play an important role in defining the IT strategy of their business. Cloud computing offers various benefits such as scalability, elasticity, reducing IT expenditure considerably. Moreover, the architecture of such a utility computing consists of service models and deployment models which have been explained in the paper .Security is a key concern in all the web applications when they start interacting with applications in the public domain. The purpose of this paper is to provide the key security issues in service models of Cloud computing: Infrastructure-as-a-Service, Software-as-a-service and Platform-as-as-service. Finally, the paper will discuss some of the solutions been offered by cloud service providers for the following service models: Software as a service (SaaS), Platform as a service (PaaS) and Infrastructure as a Service (IaaS).

Acknowledgement

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Table of Contents

1   Introduction

21st century businesses needs efficient IT infrastructure to run successfully and be competitive. IT services and solutions are becoming important in running businesses and the firm using most efficient IT services gains competitive advantage over the other firms. Among the various IT services and technologies, Cloud computing is one of the computing services which can provide operational efficiency and reduce cost. Cloud computing is a disruptive innovation and relatively a new computing model in which information, computer resources and applications can be controlled from web by customers. Some of the Cloud computing benefits are cost reduction in capital , elasticity, efficient use of computing resources .Analyst believe within cloud computing business will grow to $95 billion and 12% of software market will move to cloud computing. To address this enormous demand, cloud computing has some of the challenges related to security of data. In any web applications when the data is been transferred across public domain one of key challenges remain is the security and privacy of data. Cloud computing has different deployment levels and service models .Deployments levels are private, public, community and hybrid models. Then there are three delivery models SaaS (Software as a service), PaaS (Platform as a service) and IaaS (Infrastructure as a service).These layers form the essentials of the cloud computing and exhibit characteristics such as elasticity, multi tenancy. Figure 1 shows the complexity of security in cloud computing.
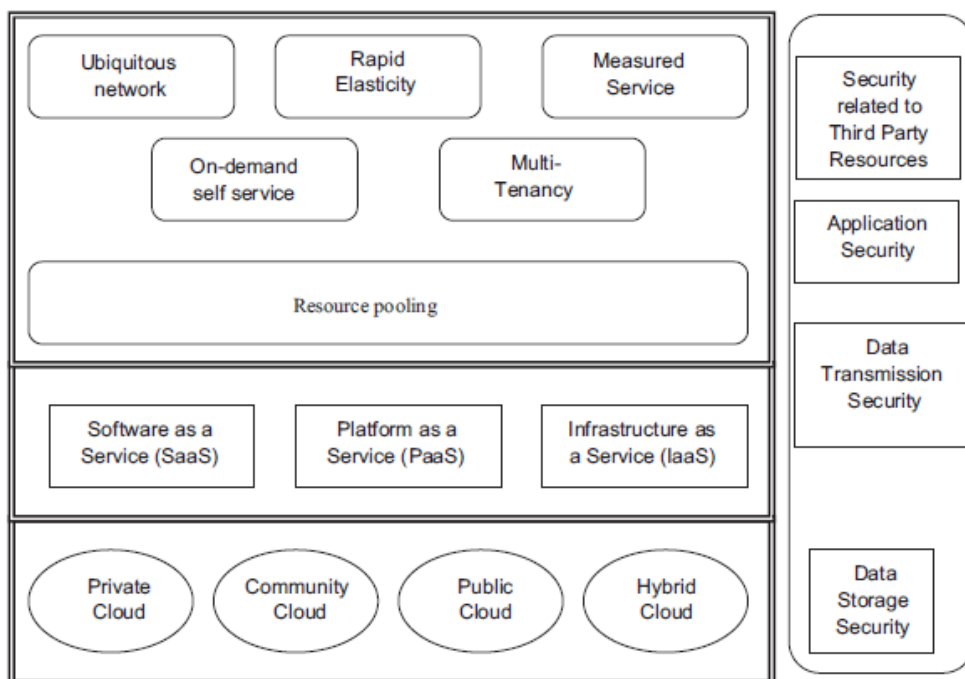
Fig. 1. Complexity of security in cloud environment.

(Source: Journal of Network and Computer Applications, 2011)

This paper will start discussing the literature review on cloud computing, benefits and role of Cloud computing in IT Strategy in section 2 .Section 2 describes key security issues in service models of cloud computing .Section 3 describes the data methodology adopted to get information .Section 4 describes the various solutions been offered by IT service providers for these security issues in service models. Section 5 provides the discussion of some high level ideas .Section 6 provides the conclusion derived out of this study and the paper gives recommendation in section 7.

2 Literature Review on Cloud Computing

2.1 Definition of Cloud Computing

Cloud computing has the potential to change the infrastructure of IT industry, making software services smarter and IT hardware purchase to be more cost efficient(Armbrust et. al.2011); Businesses would not need to invest huge amounts of capital in IT infrastructure to achieve successful deployment of service or the capital expenditures to function it effectively. Moreover, organizations with large scale defined tasks can get results in a timely manner. In other words, the utilization of cloud computing makes the cost of using hundred servers for one hour almost as equal to the costs of using one server for 100 hours.

Cloud computing can be defined as business applications or software applications delivered as services over the web and the hardware and systems software in the data center that provide those services (NIST, 2009). A cloud consists of hardware and software of the data center. When this cloud is available to the general public in the 'pay as you go' service then it's referred to as public cloud, and hence the service will be sold as a utility computing. However, when these data centers are internal to the businesses or organizations and are not made available to general public then it is referred to as private cloud.
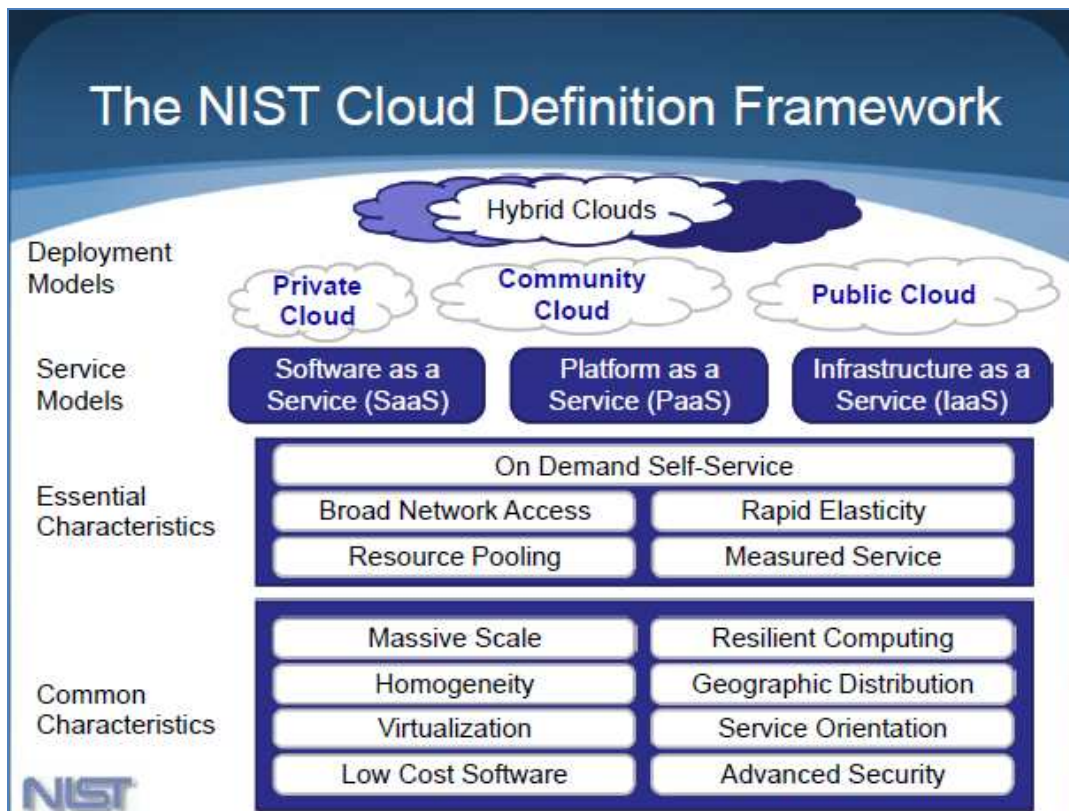
(Source: National Institute of Standard and Technology, 2009)

Another definition of Cloud computing is given by Mell & Grance(2009) who define it as " *the model for enabling convenient ,on-demand network access to 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"*

Cloud computing provides an interestingly new dimension to hardware provisioning and pricing view:

→ Scalability of infinite computing resources on request, highly responsive to follow sudden load demand, this in turn reduce the necessity of customers to plan ahead for provisioning.

→ Mitigating the need of users to commit unnecessarily, hence, cloud computing provides small medium enterprises the opportunity to scale only when there is need.

→ Facility to pay for utilizing the resources of cloud computing based on short term ground when desired and then release them when not needed, thereby rewarding conservation by letting resources and storage space go when they are not required.

ACM Journal states that main idea of Cloud computing came from the concept of building computer data centers which are of large scale and low cost locations. This in turn results in significant decrease in electricity usage bills, network bandwidth, operations, usage of software and hardware resources. These factors combined with "*statistical multiplexing*" provide a higher level of utilization as compared to traditional data centers meant cloud computing could offer services below the costs of medium sized data center and still make a good profit (ACM, 2011).

Below example illustrates the difference between cloud computing model and non-cloud computing model:

→ Public internet hosted on Internet Service Provider, which can allocate machines to customers demand given advanced notice. However load surge on public internet can happen more hazardly or dramatically. This is not an example of cloud computing.

→ Enterprise data center mostly with organizations within which requests are amended only with notable notification to the administrator. In this scenario large load surges on the scale of time is unlikely, as long as allocation of resources can manage expected load increases, this scenario shows one of the places where cloud computing can be implemented.

Cloud Computing Economics

Reasons for using Cloud computing over the conventional computing model:

Demand of service varies with time. For example Organization can pay by the hour for using computing resources.

→ When Demand of resources is unknown in advance. For example, Internet Startup enterprise would need more support when it becomes popular, followed by reduction once some visitors turn away from their website.

→ Organizations providing batch analytics can use the "cost associativity" of cloud computing for finishing computation faster.

Cloud computing can be termed as converting the capital expenses to operating expenses (ACM journal, 2010).

One of example from Communications of the ACM, 2010 to communicate the point of converting capital expenses to operating expenses, can be shown that if a service has a predictable demand where the peak requires 500 servers at the noon but only requires 100 at midnight. "*As long as the average utilization over the whole day is 300 servers the actual cost per day is 300 X 24 = 7200 server hours, but since the provision to the peak of 500 servers we pay for 500 X 24 = 12000 server hours a factor of 1.7 more*"(ACM journal,2010).

From the above example it can show that in this model of pay-as- you-go cost of server over three years is less than 1.7 times the cost of buying the server.

Figure 2. (a) Even if peak load can be correctly anticipated, without elasticity we waste resources (shaded area) during nonpeak times. (b) Underprovisioning case 1: potential revenue from users not served (shaded area) is sacrificed. (c) Underprovisioning case 2: some users desert the site permanently after experiencing poor service; this attrition and possible negative press result in a permanent loss of a portion of the revenue stream.

(a) Provisioning for peak load

(b) Underprovisioning 1

(c) Underprovisioning 2
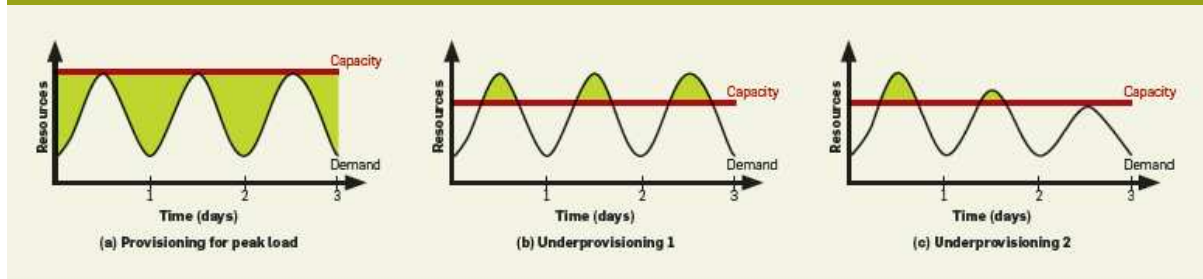
(Source: Communication of the ACM, 2010)

The common element in computing world happening is a shift in geography of computation (Communication of the ACM, 2008). Shrink wrap software is still prevalent in the market but focus

on innovation is ascending into clouds .This change will affect the overall ecosystem comprising of hardware, software, IT Managers, causal user to software users and hardware manufacturers.

Cloud computing can be said to be the second phase of IT revolution. Almost five decades back, a similar revolution was developed based on the rational of "*time sharing systems*" (ACM,2010) that offered the opportunity to access to computing machines for users who faced lack in mainframe .A typical "*time sharing service is hub and spoke*"(ACM,2010) configuration. In this model, Individual users communicated through telephone lines with a central line where all the computers were based. In 1980s the personal computers came which took out the programs and data from central computing center. In the current trend, locus of computing is shifting again with functions moving outward to distant data centers.Nowdays a computer is interacting simultaneously with a large number of servers, which may be exchanging information among them. In 1990s and early 2000s corporate IT managers and end users were squabbling over the possession of computer resources, but now both sides are willing to surrender this possession to third party .The change in this attitude is the operational cost. Operational cost covers installation of hardware & software, maintenance, upgrading of services and related activities. Every update in any one them require revision of all other activities as it has got a cascading effect. This is turn effects the operations of the business, due to which it can lose competitive edge.

The Objective of cloud computing is to have a central place where resources related to computation and storage are kept at the core, and where high performance resources are linked with high bandwidth connectivity.

Cloud computing doesn't have standard definition, but a working definition as given by IEEE,2009 "*clouds or clusters of distributed computers, provide on-demand resources and services over a network, usually the internet with scalability and reliability on a data center. Clouds are those which provide computing instances on demand and those that provide computing capacity on demand*".

Cloud computing is used because of the following reasons as given by Grossman, 2009:

"Scale" (Grossman, 2009): Cloud computing has the ability to scale quickly as when required by the firms.

"Simplicity" (Grossman, 2009): Before cloud computing came as IT revolution, writing code for high performance programs and distributed computing was complex and usually required working with grids, passing highly coded messages between nodes. Although most people in computing industry feel that cloud based storage service APIs and Map reduced style computing APIs are quite naïve as compared to earlier methods.

"Pricing"(Grossman, 2009): Cloud computing is offered as pay as you go model and is billed by the number of hours services are been used. For example if a firm needs 1000 computing resources for one hour, it will pay only for these 1000 resources, so over here no capital expenditure is required.

According to Singh and Bansal (2010), "*Cloud computing is defined as a model for enabling a convenient, faster, scalable, on demand network access to shared pool of resources (eg. Servers, Software Platforms, Applications, Services) that can be rapidly provisioned with minimal management effort or service*". Cloud computing offers many benefits such as large storage space, infrastructure benefits, scalability and ease of using information from anywhere.

Cloud computing is still a very young and dynamic field characterized by a buzzing industry. Virtually every organization in the industry and even parts of the public sector is taking on cloud computing today, either as a provider or as a consumer. Primarily US-based companies, such as Amazon, Google, or Microsoft are currently shaping the cloud services market. But many smaller companies are also showing a lot of commitment in this field. There is no doubt that cloud computing is a disruptive technology which has the potential to change our understanding of how to provision and leverage IT services in a fundamental and sustainable way. The effects might even be comparable to the introduction of the personal computer some 25 years ago.

2.2 Efficiencies of Cloud Computing

According to the Communication of the ACM journal (2010), the following three practices can be suggested:

WordStar for the Web: Productivity tools such as Google docs give users to make word documents, power point presentations, spreadsheets. Software is Catchword; a web based word processor which was acquired by Adobe systems in 2007.

Enterprise computing in the cloud: In last decade the software for major businesses was run on the corporate servers residing in the premises of the organization. But lately this trend has changed and several companies provide this facility on demand. The first offering was by Salesforce.com founded on 1999, whose slogan was 'No Software'.

Cloudy Infrastructure: Cloud computing will lead to outsource the building and maintenance of data center to third party vendors, these vendors will be there for providing infrastructure for this service. Already few big names are there such as Amazon Web Services which offers storing data at their data centers priced by "*gigabyte-month and computing capacity by CPU hour*"

(Amazon,2011).IBM has announced plans for "Blue Cloud" (IBM, 2010) infrastructure, Google is testing AppEngine which provides hosting on Google farms.

The Cloud OS: In maximum cases of the cloud computing applications the user interface resides in one only interface. Several initiatives are been taken to provide a rich user experience for internet applications. One of the approaches is exploiting how to provide all the facilities of an operating system in the browser itself. Some firms like Eyes system reproduces the desktop metaphor with icons for file, folders and applications –all living in a browser.

A paper published by IEEE (2009) there are several reasons for using cloud computing over the conventional model:

"Elastic, Usage based Pricing" (IEEE, 2009)

Cloud computing is offered with a usage based model, which requires the customer to pay as per the usage of the resources. Computations which require additional resources at any point of time are requested from the cloud management. The term elastic or utility computing is used to describe the ability of cloud to provide resources as per the demand. Firms get several options for obtaining cloud services either owning a private cloud or buying cloud services from a third party vendor. This pricing model offers important advantages such as:

➔ It doesn't require any capital investments, as using utility services, users pay as per the usage.
➔ It lets user access the exact capacity as and when required.

One of the examples taken from Communications of the ACM, 2011 to show how the utility model is cost effective:

A firm A has requirement of 100 servers to operate over period of three years. There are two options

" Option A: Lease the servers at $ 0.50 per instance hour.

*Cost = 100 servers * $0.50 instance-hour * 3 years * 8760 hours/year = $1,314,000.*

Option B: Buy the servers.

Assumptions: Each Server cost is $1500 , 2 staff members at $100,000 to administer , servers require 150 watts each, with the cost of electricity at $0.10 per kilowatt-hour , which takes the yearly cost to operate 100 servers to $13,140.

*Cost = 100 servers * $1500 + 3 years *$13140 electricity/year + 3 years * 2staff * $100,000 salary / year = $789,420.*" (Communications of the ACM, 2011)

From the example the cost of buying servers is coming to be less, but if these servers were to run on 75% utilization or less, using on-demand model would be less expensive.

Benefits of Cloud Computing:

Cloud computing model offers several benefits over the traditional computing model:

➔ Cloud computing offers usage pricing model .This model offers benefits such as reduced capital outlay, low barriers to entry, scalability as and when required, support brief surges in capacity.

➔ Cloud computing enjoys economies of scale comparable to data centers. Hence, efficiently in business procedures, consistency and level of security are all enhanced far more significantly.

➔ Cloud computing architecture is very scalable for example managing a petabyte of data is easy in cloud computing whereas in traditional it's very problematic.

Chandran and Angepat(2010) states some of the advantages of cloud computing as reduced cost model, small scale industries can get better computing environment, hardware failure can be localized, various data centers are spread across geography and makes easy from firms to choose, cloud computing environment is easily scalable.

2.3 Role of Cloud Computing in IT Strategy

In the world of globalization, information technology plays an important role by which data is collected and put into the process of interpretation in order to provide an integrated series of information for further communication and analyzing. Just as labor was probably the most critical resource in industrial age, capital in industrial age and information technology will be most critical in postindustrial age. A good IT strategy plays important role in maximizing business value and is a business change enabler and innovator.
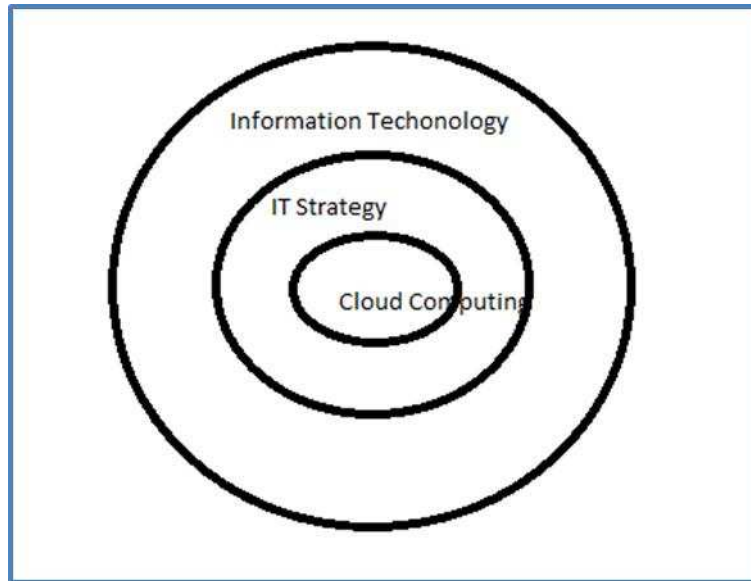
Figure 2.3 Cloud computing a subset of IT strategy and IT

Information Technology nowadays plays a very important role in this era of uncertain economic conditions. The technology is offering lot of advanced capabilities at lower costs than ever before. Information technology can be used to improve the efficiency and effectiveness of the firm, help in getting competitive edge in the industry, also to an outsider whether to enter the industry or not. Information technology main focus nowadays is to improve the efficiency and effectiveness of the business .Rockart and Scott has suggested that traditional information systems have important role for the competitive position of the firm.

Rockart and Scott Morton have introduced the use of value added chain to describe the potential of value added chain to create competitive advantage. They have identified opportunities that can create competitive advantage: by improving each function in value chain 2) link between customers and suppliers so as to increase switching costs 3) develop new business through service or product.

IT Strategy can be defined as the organizations overall objective, principles, a well-defined path for the use of technologies available that the organization uses to get competitive advantage. IT Strategy will primarily focus on: "*the efficiency of the company's spending on technology; how the organization's customers and employees exploit technologies in ways that create value for the organization; on the full integration of technology-related decisions aligned with the company's strategies and operating plans*"(Wikipedia,2011).

IT Strategy is an iterative process to align IT capability with business requirements which matures after repeated back and forth process. The goal is to allow considerable alignment level of between business and IT capability instead of intending to design IT to address business.IT strategy act as a

guideline for IT function in an enterprise. A good IT strategy ensures cost reductions in IT budgets, bringing efficiency to business and maximum value overall.

Cloud computing perfectly fits into IT Strategy as it has cost benefits associated with its usage, it's on demand model will not be a constraint to the organizations for need of resources as and when required.

Cloud computing can be seen as disruptive innovation, which has the potential to revolutionize the mode of computing resources and application deployment.

As can be noticed from the research done in the areas of information technology, IT Strategy and cloud computing, they are subset of each other in today's business as shown in Figure 2.3. They are all interconnected and play an important role in the cost reduction, effectiveness of business process, and scalability of the software or hardware service. This relation can be shown from the Figure 2.3 as cloud computing is a subset of IT Strategy and IT strategy is a subset of Information technology.

IT strategy is not a new term but even advocated by Michael E. Porter.

According to Porter (1980), firms' activities which entail the steps of design, production, delivery and support of products and services mainly stem from the ideology of value chain activities. A value chain combines various steps and procedures through which products and services are developed and manufactured. In internet services for instance, value networks are a mixture of network of suppliers, distributors, customers that are all interlinked through internet and other electronic means in order to generate value to the customers (Tapscott et al. 2000). While in IT services infrastructure, the value chain can be broken down into infrastructure, applications and business processes which are supplemented by strategies and consulting. However, the IT services cycle mainly comprises three aspects: plan, build, and run. Although these parts of the IT cycle must be supported and implemented, businesses have the flexibility to decide whether to keep them in house or to outsource them to a number of different vendors as the latter choice can contribute significantly in cost reduction and efficiency increase. Finally, when it comes to the process of IT hardware purchase, installment and hosting services can be either done by the customer or can be achieved through a hosting provider. Nevertheless, the last option may result in notable level complications between both of the parties.

As far as cloud computing is concerned, the process of outsourcing the traditional value chain can become far more complex with immensely huge number of combinations which in turn depict a

multifaceted network rather than a sequential one. Part of this new complexity can be found in general trend from products to services (Jacob and Ulaga 2008). Consequently, This trend may lead to more outsourcing but in the same time similar trends can be applied to software services, hardware services too. Cloud computing uses two areas of hardware outsourcing to 'as a service' concept .Cloud computing has two big facets: infrastructure services are offered dynamically to the customers and they are charged as per usage which can be calculated on hourly basis.

While there can be little doubt that the cloud computing is capable of integrating both hardware and software via various computing platforms, these platforms lead to the creation of new creating new, single and composed applications that support complex processes and interlink data sources. Analyzing such platform through value chain lens, it is clear that there is some type of market value and different cloud computing resources that are blended together and hence are provided to the customer.

2.4   Virtualization Technologies in Cloud Computing

According to Institute of Architecture of Application Systems, Virtualization in computing is described as resource of one physical computer can be portioned into logical resources and rearranged into virtual machines. Virtualization helps in increased utilization of single physical computer by allowing running heterogeneous application stacks. Since applications run on different virtual machines they are independent from each other thus contributing to maximum availability of the physical machine in case any individual machine crashes. Virtual machines can be cloned and then moved from one physical computer to another thus contributing to scalability of the environment.

Clusters are the other way of increasing utilization, scalability and availability of individual computers. A cluster is an "*interconnected set of complete computers (i.e. ones that can be used as standalone computers) that are perceived from the outside as one big computer*" (Leymann, F. ,2009). Cluster will only ensure load on computers are evenly utilized.

Grid: A Grid is like a cluster which is a set of interconnected set of computers perceived as a single computer from outside. A grid supports individual applications instead of a whole application mix, it is not owned by a single company but consists of computers owned by organizations willing to share with other virtual organizations.

Virtualization of software and hardware supports the utility and demand computing.
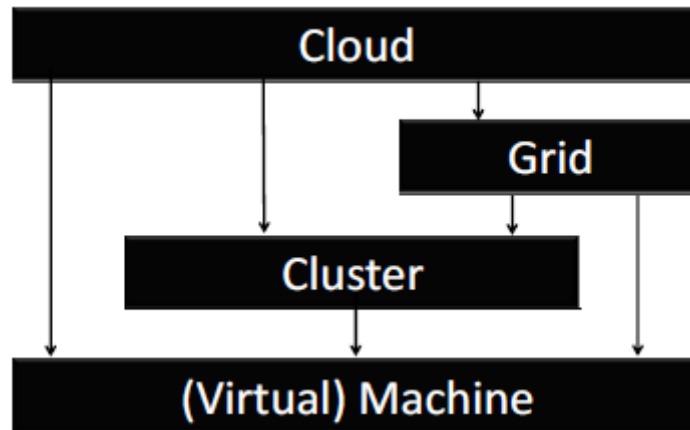
(Source: Institute of Architecture of Application Systems, Implementation options for Clouds)

According to Menasce (2005) the main motivation for virtualization in the seventies was to encourage growth in sharing and usage of expensive resources of computing like mainframes, 80s saw decrease in hardware costs that saw shift of organization portion of computing needs from centralized to departmental minicomputers. With the advent of microcomputers and other technologies in 90s brought distribution of computing to new height. Large numbers of client machines were connected to various servers which brought some issues with it such as consistency, security, privacy, and increase in administration cost and difficulty to manage, floor space increased, rise in power usage, and thermal dissipation requirements .Virtualization helps in overcoming these problems.

Virtualization allows running two different instances on the same machine in such a way that these two instances are isolated from one another.
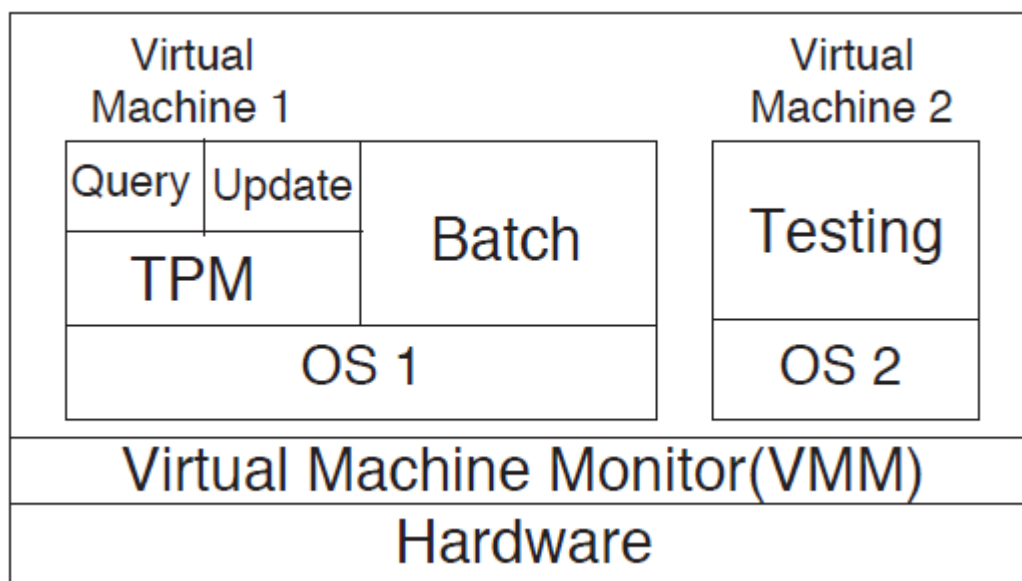
From the above diagram, production environment runs on OS1 and test environment runs on OS2.Both of them run on "*Virtual Machine Monitor (VMM), VMM virtualizes all the resources i.e. processors, memory, secondary storage, networks) and allocates them to virtual machines*".

Cloud computing is a further evolution of a highly virtualized environment. Without virtualization, there would not be a Cloud. Clouds rely on virtualization to create highly elastic and flexible pools of servers that can be dynamically provisioned to adjust to service operations, workload changes and end users request for services. Virtualization may also be applied to storage, networks and other components of the cloud. Service management is as critical to managing the virtualized aspect of the Cloud as it is to Cloud itself. You could say that virtualization and service management are two key prerequisites to any Cloud. When you hear people refer to virtualization management, they are actually referring to a service management system for a virtualized environment.

Advantages of Virtualization:

"Security:" (M.N.Bennani and D.A Menasce, 2005) Virtualization does compartmentalization which has different security requirements; one can select appropriate tools for each environment. For example a security attack on one virtual machine will not impact other machines because of segregation.

"Reliability and Availability:" (M.N.Bennani and D.A Menasce, 2005) A software failure in one will not impact others.

"Cost:" (M.N.Bennani and D.A Menasce, 2005) It is possible to achieve cost reduction by consolidating small servers into big server. Cost reduction comes from hardware reduction cost by having economies of scale, operation cost reduction, floor space, software licenses. VMware cites cost reduction in the range of 29% to 64 %(VMware, "Consolidating Mission Critical Servers")

"Adaptability to workload Variations:" (M.N.Bennani and D.A Menasce, 2005) Workload can be easily be reduced by moving resources and prioritizing the allocation of work among virtual machines. "*Automatic computing based resource allocation techniques can be used to dynamically move processors from one virtual machine to another*" (M.N.Bennani and D.A Menasce, 2005)

"Load Balancing:" (M.N.Bennani and D.A Menasce, 2005) Virtualization encapsulates the software state by VMM, thus helping to easily migrate virtual machines to other platforms to advance performance.

"Legacy Applications:" (M.N.Bennani and D.A Menasce, 2005) If an organization chooses to shift to a another operating system which is different than the first one, or aims at moving to an updated or different version, it is possible to run the legacy systems on the old OS through virtualization, running it as a guest OS in the Virtual Machine (VM), thus reducing migration cost.

2.5   Deployment Models in CC

2.5.1   Private clouds

In this deployment model, cloud computing is on private network. Private clouds give complete control to the end users regarding the security and how data is to be managed. This can give customers more confidence regarding their data storage.

According to Sohan and Zeng (2010) either the organization or third party may be responsible for the clouds management in order to increase the efficiency and effectiveness of the model.

Ramgovind, Smith, Eloff (2010) states private clouds as cloud which is setup in organizational boundary.

2.5.2   Public clouds

In this deployment model, numerous numbers of customers can have a access to the web applications and services within the internet simultaneously. Each customer gets its own individual resources which are dynamically allocated depending on the demand and usage by the third party vendor. The third party vendor hosts the cloud for multiple customers such that the architecture consists of multiple data centers, also providing the security with hardware and infrastructure support for the cloud to operate. The customer doesn't have the insight into how the cloud is managed by the third party vendor.

Similarly European, Mediterranean and Middle Eastern conference on Information Systems, May2011, organizations using public clouds, it is necessary to Service level agreements (SLA) need to be enforced. The virtualized resources may be controlled within a public cloud; simultaneously it can take control of the local infrastructure.

Figure 2: Public Cloud Deployment Model
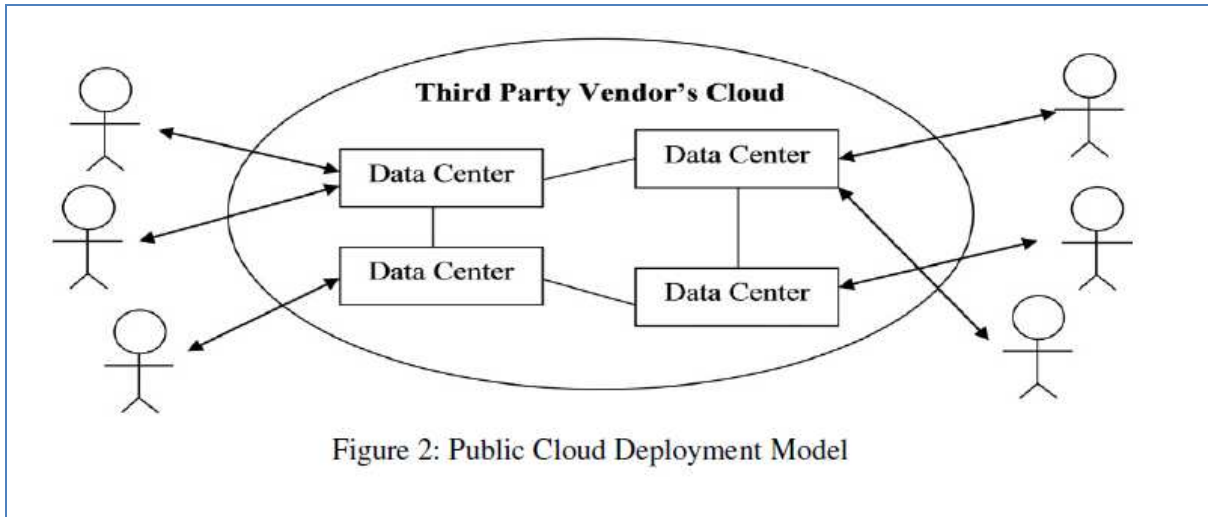
(Source: Cloud Computing Security, International Journal of Ambient Computing and intelligence)

2.5.3 Community clouds

According to NIST (National Institute of Standards and Technology, Information Technology Laboratory) definition of community clouds are those in which "*cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns such as security, mission, requirements, policy and privacy considerations*" (NIST, 2009). This cloud infrastructure can be managed by the organization itself or outsourced to third party.

2.5.4 Hybrid clouds

This deployment method incorporates both public and private clouds. It gives the organizations the benefit of using both the models to maximize efficiency .for example an organization can use private cloud for data storage and public cloud for traffic handling and demand.
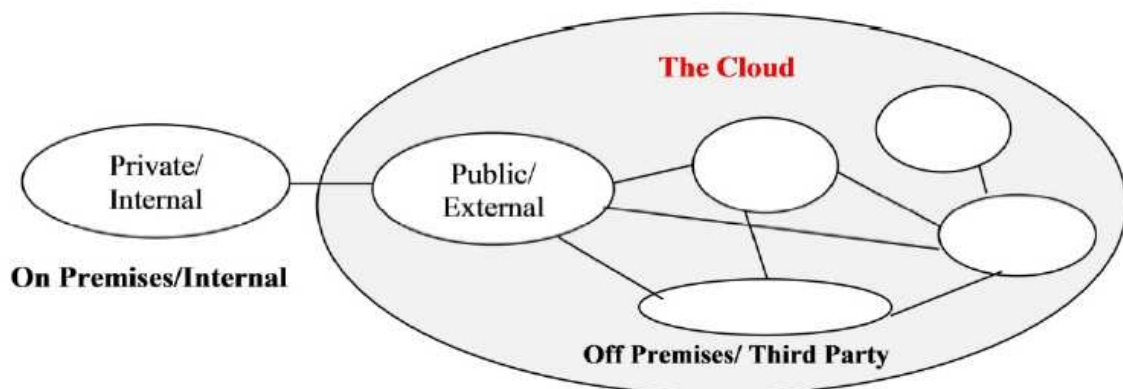
(Source: Hybrid Clouds, Cloud computing security, International Journal of Ambient Computing and Intelligence, June 2011)

Ramgovind, Smith, Eloff (2010) states hybrid clouds as a private cloud linked to one or more external cloud services managed and provisioned as single unit. Hybrid clouds provide more secure control of data and applications.

2.6   Service models in Cloud Computing

An Overview of the service models as given by Information Systems Evaluation and integration group:

Layer	Characteristics	Examples
SaaS (Hosting and providing services)	• Avoidance of local install & run *(Wang et al., 2010)* • Maintenance free (for user) *(Wang et al., 2008)* • Reduced purchasing software cost *(Clemons and Chen, 2011)* • Pay as-you-go • Security based on SSL *(Velte et al., 2010)*	• Salesforce • Netsuite • Google Apps
PaaS (Development platform)	• Services and applications development *(Foster et al., 2008)* • Hosts both completed and in-progress applications *(Dillion et al., 2010)* • Supports development of web interfaces such as Simple Object Access Protocol (SOAP) and Representational State Transfer (REST) for mashups deployment *(Velte et al., 2010)*	• Microsoft Azure Service Platform • Saleforce - Force.com • Google App Engine • Amazon Relational Database Services and Rackspace Cloud Sites
IaaS (Computing resources)	• Processing power, Storage, Network *(Sohan and Zeng, 2010)* • Virtualization *(Bhardwaj et al., 2010)*	• Amazon S3 (Simple Storage Service) - EC2 (Elastic Cloud Computing) • Rackspace Cloud Servers

(Source: Information Systems Evaluation and integration group)

2.6.1 IaaS (Infrastructure as a Service)
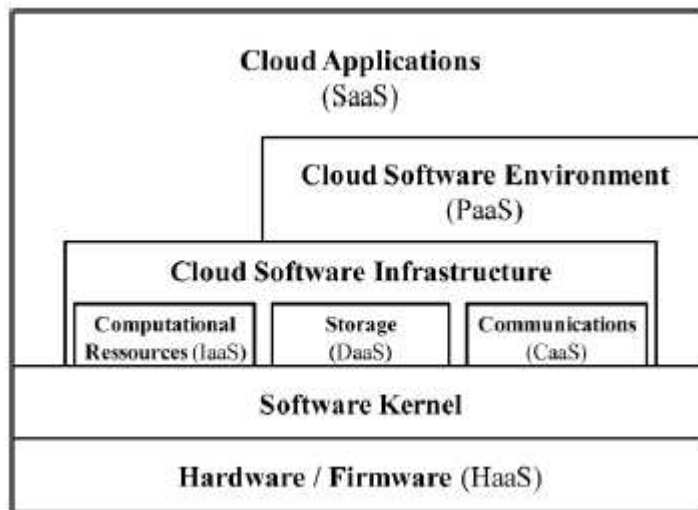
(Source: The Layers of Cloud computing, Yousef et al., 2008)

Yousef et al. (2008) were among the first one to give unified ontology of cloud computing. According to Yousef et al. cloud computing systems fall into: "applications, software environment, software infrastructure, software kernel, and hardware". Each layer is a level of abstraction, hiding the user from the other layers and providing simplified access to the resources.

2.6.2 Software as a service:

It can be defined as the cloud application layer which is the most visible layer that can be accessed through various portals of the internet and hence builds the front end for user s by which it interacts with cloud services. However, although this service would often be interlinked with another cloud computing service provider's website, the end user will view it as an individual service. This mode of software provision is referred as *Software as a service.*

Software as a service is defined by Morsy et al. (2010) as where the cloud providers deliver applications hosted on a cloud environment as internet based service to end customers.

2.6.3 Platform as a service:

It can be defined as the Cloud software layer which provides the environment to the developers for programming cloud applications. The software environment also provides the Application programming interfaces (API) to exploit cloud services and to interact with other cloud applications. Features like automatic scaling, load balancing, authentication services, communication services or graphical user interface (GUI) components are all of significant use to the Developers.This service provided in the software environment is called Platform as a service.

Platform as service is defined by Morsy et al.(2010) as where the cloud providers deliver platform, tools and other business services that enable user to develop, deploy and manage applications.

2.6.4   Infrastructure as a service:

It can be defined as the layer which provides resources to higher level layers which are then utilized by cloud applications and cloud software environment. The services in this layer are uniquely distinguished into computational resources, data storage and communications. These computational resources are termed *as* Infrastructure as a service*.*

Infrastructure as a service is defined by Morsy et al. as where the cloud providers deliver computation resources, storage, and network as an internet based services.

Data Storage as a service (DaaS): It gives the flexibility to users to get on elastic demand storage on remote disks which are accessible from anywhere.

Communication as a service (CaaS): It is mainly concerned with quality of service including network security, dedicated bandwidth or network monitoring.

Hardware as a service: It is the actual hardware which forms the backbone of the cloud computing. Hardware such as data centers can also be sub leased by service providers to large enterprises.
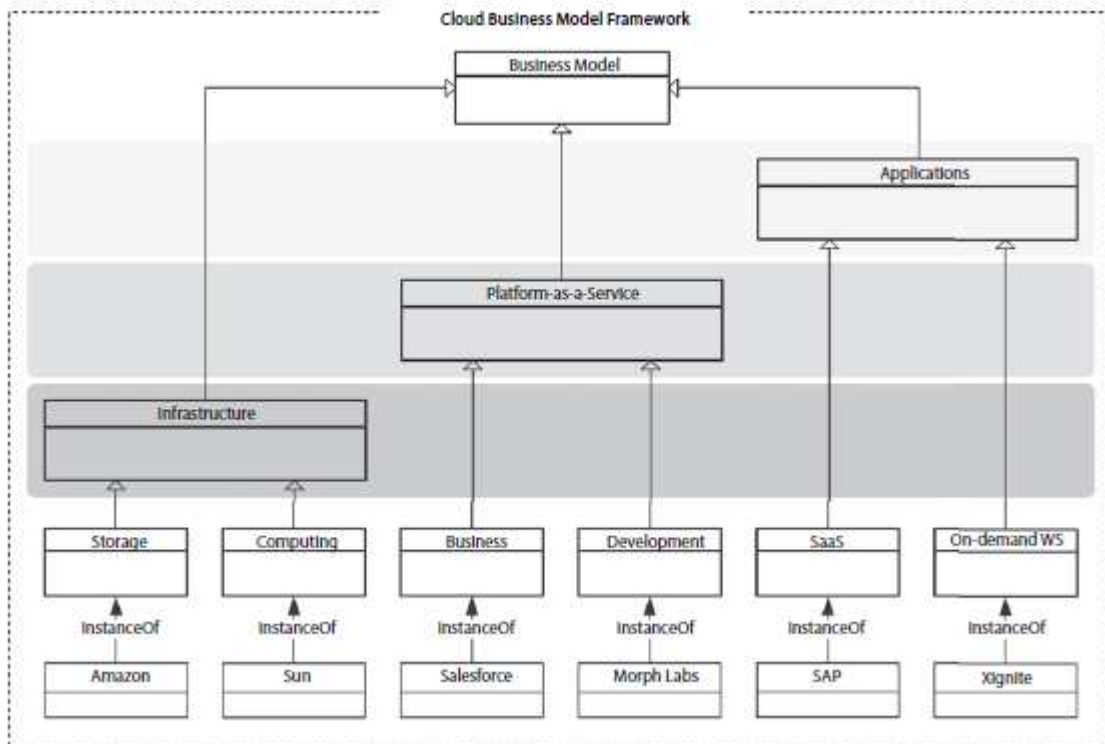
(Source: Cloud Business Model, Business and information systems engineering, 2009)

Lately Business and Information systems engineering (2009) came up with a model to explain the cloud computing which is termed as cloud business model framework. This model can be mainly categorized into three layers: infrastructure layer, platform as a service layer, and application layer on top.

Infrastructure in the cloud – The infrastructure model gets business model that focuses on providing cloud computing ecosystem. This is further classified as one providing storage capability and other providing computational capability. Cloud computing infrastructure is organized into a cluster like structure facilitating virtualization techniques.

Platforms in the cloud – This layer represents platform solutions on top of a cloud infrastructure that provides value added solutions from a technical and business perspective. It consists of business and development platforms. Development platform enable the developers to build their own code and upload their code which are then accessible to end user. Developers don't have to worry about scalability issues.

Applications in the cloud – Application layer is the visible interface layer which a user's get to see which is facilitated by the platform and infrastructure layer.

2.7 Key Security Issues in Cloud Computing

Security is very vital for the cloud computing model to succeed in future .Security can be related to privileged user access, regulatory compliance, data location, data segregation, recovery, investigate support, long term viability.

According to International Journal of Ambient Computing and Intelligence, cloud computing security is still infancy and there are number of organizations and standard bodies drafting cloud standards and APIs. Cloud security is important for organizations especially when individual's personal information or business sensitive information is being stored in the cloud as the information is in millions of bytes.

According to Ramgovind et al.(2010), IEEE use of cloud computing environment can be effectively managed and controlled in an organization if the strategic and business decision makers begin to access the potential impact of cloud computing on their competitive edge. While developing the cloud framework it is necessary to have policy on information security, data protection, trust and privacy which are a part of security. This will help to protect the cloud from potential threats, hacking and loss of information. A transparent security would necessitate cloud providers disclosing adequate information about their security policies, design and practices. SLA (Service level agreements) will play an important protocol in transparency. These SLA can have features such as services to be delivered, tracking and reporting, problem management, legal compliance, resolution of disputes, security responsibilities, and confidential information.

According to 2nd IEEE International conference on cloud computing technology and sciences, some of the issues that can arise in cloud computing model are unauthorized usage of data by service providers, theft of data from machines in the cloud, fear of leakage of sensitive data or loss of privacy. The issues can be categorized into privacy, security and trust issues.

Privacy: Privacy risks depend on the type of cloud scenario. Some of the cloud applications might have a low risk for example if the service is to process that is public. If it collects, transfers, stores the personal information, in this case privacy will be low. However services which dynamic personalized depending on personal information such location, preferences, social networks would require privacy to be taken into greater detail. Public cloud is the most dominant architecture when cost reduction is seen but just relying on the service provider will increase the security risk. Some of the risks can be lack of user control, unauthorized secondary usage, data proliferation, trans border data flow and dynamic provisioning.

Security: Security is to create a trust boundary where there is control over the computing resources and sensitive information can be stored and processed. Some of the security issues identified in the conference were: abuse and nefarious use of cloud computing, insecure interface and APIs, malicious insiders, shared technology, data loss or leakage, account hijacking unknown risk profile.

Trust Issues: From the contemporary, cross disciplinary, collection of scholarly definition "*Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another*" (Rousseau, D., S Stikin, R.Burt and C.Cmaerer,1998). Trust issues can be weak trust relationship and lack of customer trust. Weak trust relationship can arise if there is a weak delivery chain but it exists in order to have a faster service. There can be significant issue when cloud transaction happens. Organizations that contract business process might not know whether the contractor is sub-contracting the process. Trust along the chain from customer to cloud providers may be non-transitive and customer may not trust some subcontractors. Cloud computing models 'pay-as-you-go' or on-demand' may be based on weak relationship which can involve third party vendors having lax data security practices, expose data , make deletion hard to verify.

According to the International Journal of Network Security and Its Applications (2011) security concerns in cloud computing are the physical location of the data that are being saved and kept especially if they are allocated in different countries, as the laws in the host country may be different the laws of the other country where data centers are there to store the data.

According to Cloud Security Alliance (CSA) there can be security threats to cloud computing model which may be:

- Manipulation of cloud computing model
- APIs not secured
- Malicious insiders
- "*Shared technology vulnerabilities*"(CSA)
- *"Data Loss or Data leakage"(CSA)*
- "*Account service and traffic hijacking*"(CSA)

Talbot (2009) stated that it is possible for attackers to map the target data physical location within the cloud and use various ways to gather intelligence.

According to Jing and Jian-Jun (2010) some of the key security issues in cloud computing are:

Cloud computing doesn't have defined boundaries as traditional computing environment .As the security is controlled by the service provider, if something goes wrong ,user data confidentiality will

be at risk. Jing states that there can be issues related to location of user data, storage of data, data recovery, data encryption and data integrity. Due to the dynamic changes in cloud computing there is a issue of how to secure the communications among the various subjects such as security and integrity.

According to International Journal of Engineering Science and Technology (2011) have described "*XML signature element wrapping; browser security; cloud malware injection attack and flooding attacks*" as the main security issues.

According to AlMorsy and Muller(2010) despite the benefits of cloud computing such as multi-tenancy and elasticity among major ones, the model has many open issues which impacts the model credibility and persaviness.some of the issues highlighted are "*Vendor lock in, multi tenancy and isolation, data management, service portability, elasticity engines, SLA management, and security*"(AlMorsy and Muller,2010).

According to Journal of Network and Computer applications (2011) by Pietro and Lombardi, one of the key issues in cloud computing is loss of data control. In Cloud computing model, data is can be stored or processed across international boundaries this can expose the security threats.

2.8   Security issues in Service Models

Cloud computing, consists of three main models through which services are delivered to end users. These delivery models are: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS); there are several advantages that result from applying this model. Firstly, they provide infrastructure resources, application platform and software services to customer. Furthermore, these models also establish different level of security requirements in the cloud environment, IaaS is the basic bedrock of all cloud services, PaaS is built upon it and SaaS in turn built upon it as can be shown in diagram 2.8.

Software as a Service(SaaS)
Platform as a Service(PaaS)
Infrastructure as a Service(IaaS)

Diagram 2.8

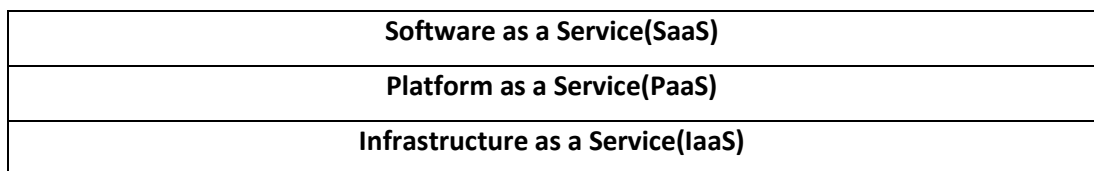As the capabilities are inherited from the web so are the security issues and risks associated with it. A survey done some time back by IEEE and Cloud Security Alliances (CSA) suggests that companies throughout different sectors are very ambitious to start the adoption process of cloud computing. However, security is a significant aspect that is taken into account by these companies to further the

adoption process and also respond to the regulation. The report also proposes that Cloud computing is expected to have major impact in shaping the future of IT while the lack of compliance environment is having an extreme effect on its growth.

SaaS is software deployment model where applications are hosted by the service provider and made available to customers as and when required. In SaaS, customers are provided with notable advantages; some of which are cost reduction and operational excellence. Nevertheless, data security and storage are some of the main issues that form an area of concern in the SaaS model. For instance, Forrester study 'The State of Enterprise Software: 2009'suggested that, the major reason because of which companies do not implement the SaaS is due to their concern about security issues. As a result, SaaS security issues are addressed as the greatest challenge for adopting the SaaS. However, some other challenges with regards the SaaS models are insider breaches in addition to possibility of having vulnerable applications and the probability of systems unavailability which in turn could result in losing sensitive data and money.

The following section highlights some of the important issues in service models of cloud computing.

2.8.1   Security Issues in SaaS

In SaaS, customers will require a considerably high level of dependency on the service provider for security issues. Thus, customers face difficulty in ensuring that proper security measures are in place and in assuring that application will be available when needed (Choudhary,2007). When SaaS is used , the cloud customer will be substituting the old software with the latest ones. Therefore, the focus is not upon portability of applications, but on preserving or the enhancement of security functionality of the legacy data and the assurance of achieving data migration successfully (Seccombe et al., 2009).

Nevertheless, while computers are increasingly becoming widely spread among enterprises since the last decade, services and computing has become an imperative commodity. Data and business procedures and practices (Business transactions, records, pricing information etc.,) are essentially strategic to the enterprises and guard them with access control and compliance policies. However customer's data is stored in data center of SaaS provider with other irrelevant data of SaaS applications. To achieve high availability, the SaaS service provider may replicate the data at multiple locations .Enterprises generally have data stored within their own boundaries and compliances. Consequently , there is somewhat discomfort level due to the lack of control and absent of knowledge about the way through which they store their data, managed and secured in SaaS model. Any risk of data loss or breach will impact the enterprise financially and legally.

According to the International Journal of Information Technology and Knowledge management (2010) performance, reliability , compliance, privacy, security, visibility under virtualization remain to be main key challenges to Cloud computing.

The European Network and Information Security Agency (ENISA), defines thirty three types of risks which are categorized into different sets:

- "*Policy and Organizational risks such as vendor lock in, loss of governance, acquisition of cloud provider.*
- *Technical risk such as leakage in data, service attacks, loss of encryption keys*
- *Legal risks such as data protection and licensing*
- *Risk not precise to cloud such as network problems, unauthorized access to data centers*" (European Network and Information Security Agency).

Pearson et al. (2010) categorized the privacy risks into two main types: individual perspective and organizational perspective. The former covers personal data exposure, lack of awareness with concerning location and jurisdiction of data. While the latter includes legal risk, audition to loss of reputation and user trust.

According to ACM providing administrative segregation between virtual customer environments is a huge challenge when elasticity is considered. Other security concerns are the ability to provide fine grained access and predefined security concerns across the entirety of virtual environment; enforcing accurate configuration and management change ; providing audit trails across virtual environments for regulatory compliance and digital forensic ,enforcement and awareness in development, controlling who is authorized to increase or contract a service.

According to Morsy et al. (2010), in SaaS model the enforcement and maintenance of security is mainly part of the responsibility of the cloud providers and service providers. However, The SaaS model may have issues such as data locality, integrity, segregation, access, confidentiality, backups.

2.8.1.1 Data Security

In conventional Onsite application model, the sensitive data resides in the organizations periphery and is subject to various checks. However in the SaaS model, the enterprise data is stored with the SaaS vendor.
The SaaS vendor must have security checks to prevent breaches from malicious employees or other security vulnerabilities (Subashini and Kavitha, 2010). The SaaS vendor can use strong encryption techniques and fine grained authorization control.

Elastic Cloud Compute (EC2) of Amazon does not give access to administrators to log in to customer instances. Users can encrypt the data before been stored at the cloud using encryption software's so that data is not damaged by unauthorized party. Also, malicious users can exploit the weakness and gain unauthorized access to data.

Chandran and Angepat (2011) states data security to be key issue in cloud computing, as data has to be secured from outside world, as it will have threat as the data is being shared among varied systems. Trust is missing in models as the providers use diversified mechanisms which lack security measures.

2.8.1.2   Network Security:
According to Journal of Network and computer applications, SaaS sensitive data from the enterprises is managed by the SaaS applications and stored at the SaaS vendor site. This data flow is vulnerable to malicious users who can exploit weakness in the network security .They can sniff the network packets and penetrate the network which can result data going to these malicious users.

2.8.1.3 Data Locality:
In SaaS model the users process their data using the applications provided by SaaS vendor. User doesn't know where the data is getting stored, this is a issues. As the data centers can be in different countries, compliance and data privacy laws will be different .In this scenario locality of data is utmost important , which will be useful when there is some issue in data then there will be a question under whose jurisdiction the data falls.

According to Advanced Materials Research (2011), knowing data location is fundamental, but as the data is distributed in this model, customers might not know where the data is stored. Although Cloud providers would commit to the local or specific jurisdiction and make contracts with the concerned authorities on behalf of their customers, customers will take some risk.

According to Jaegar et al. (2008) data locality is important by pointing out that cloud computing increases the control of government and corporation over resources.

According to Journal of Information Technology and politics (2008), level of security for cloud users will be less as compared desktop computers in many cases. The journal states researchers may be anxious about premature release of new data, and individuals are concerned about the personal sensitive data. In a cloud computing environment, Physical infrastructure is shared between

immense number users or organizations; the fate of sensitive data (e.g. personal information, medical records, and trade secrets) is at tremendous risk. The journal emphasizes on the point for the growth and adoption of cloud computing solutions it will be necessary to find technologies and policy solutions for assuring information privacy and security standards.

2.8.1.4 Data Integrity:

Data integrity in a system is achieved by "*ACID (atomicity, consistency, isolation and durability)*" (S. Subashini and V. Kavitha.,2011).In SaaS model data integrity problem is magnified, as there is a mix of on-premise and SaaS applications. SaaS application exposes their functionality through XML bases APIs and also through SOAP and REST web services. While there are somewhat fair numbers of standards available for the management of data integrity such as WS-transaction and WS-reliability but these standards are not yet developed enough to be used extensively in organizations. Lack in the control levels of the integrity at the data level can result in profound problems.

2.8.1.5 Data Segregation:

Multi-tenancy is one of the major characteristics in cloud computing , by which different users store their data at one place .Intrusion of data can be possibility in this scenario. A client can write a masked code into the application and get the whole data, as the verification is not much .As there are no boundary demarcated to segregate the data intrusion is high possibility.

According to the Advanced Materials Research (2011), data of the customers are stored alongside; there is high risk of separating storage, memory, routing and reputation between different customers.

Chandran and Angepat(2011) states data segregation is not easily done in cloud computing as all the data cannot be segregated according to users, as some users don't encrypt the data as encryption might destroy the data itself. There are chances of data not being send to customers correctly.

2.8.1.6 Data Access

Data access in cloud computing is mainly concerned with security policies provided to the users while retrieving data .Organization will place its own security consideration to the users for accessing the data .These security consideration may entitle some employees not having access to specific business sensitive data . The SaaS model should incorporate this consideration of specific policies for different users.

According to Journal of Information Technology and politics (2008) an issue which exists in cloud computing access is in the provision of international access. Cloud computing means anyone having an internet access can access the services of cloud computing. Licensing and user agreements may be different across markets. This can lead to problems for cloud computing and processing capacities available. Similarly a possibility cab be cloud users violate the intellectual property rights of others .There can be problem of public access in cloud computing.

2.8.1.7 Authentication and Authorization

In many instance users credentials are stored in the cloud of SaaS provider database and are not part of organization database, suppose when an employee leaves the company the SaaS provider should remember to remove or disable that employee credentials.

2.8.1.8 Data Confidentiality

Some of the issues highlighted by Subashimi and Kavitha (2010) are:

> ➔ Entire contents of users storage is kept with a single cloud provider or with many cloud provider there can be significant implications on the confidentiality of business and government information
> ➔ Users privacy and confidential information can vary according to the terms and conditions of the service and privacy policy
> ➔ Location of data centers may have significant impact on the information
> ➔ Information on the cloud can be in more than one legal location with differing legal consequences.
> ➔ Legal complexity makes it hard to access the information

According to Advanced Materials research (2011), as the users of cloud don't know where their data is stored, there is a risk related to regulatory compliance.

2.8.1.9 Web Application Security

SaaS is software deployed over the web/internet and is used over the local area network or personal computers. The key feature includes managing activities from a central location instead on each computer. One of the compulsory requirements is that it is to be used and managed on the web (Michal Zalewski, 2009).Security holes can create vulnerability to the SaaS applications.

According to Verizon Business 2008 Data Breach Investigation Report, it reported 59% of the breach involved hacking with the maximum happening in application / service layer – 39%.

2.8.1.10 Data Breaches

In many instances the data of various users and organizations reside together in cloud, any breach in the cloud will attack the data of all users. The cloud becomes a high value target (Chandran and Angepat, 2010).

2.8.1.11 Vulnerability in Virtualization

Virtualization is one of main components of cloud computing, one of the property of virtualization is isolation of physical machines which is not completely met in today's scenario. Some of the vulnerability has been found in the virtualization software which can be misused by malicious users to overcome the security restrictions (S. Subashini and V. Kavitha. ,2011).

2.8.1.12 Availability

Some of the concerns are the availability of SaaS service round the clock, which can happen if there is some architectural change at the application or infrastructure level.

Cloud Security Alliance defines availability for cloud computing as the data been available for critical applications on time. One of the examples given is of SAP CEO, Leo Apotheker *"There are certain things that you cannot run in the cloud would collapse. Don't believe that any utility company is going to run its billing for 50 million consumers in the cloud"*, (11/24/08, searchSAP.com).

2.8.1.13 Backup

Backup of data is necessary in SaaS applications; to recover the data at the earliest in case of any disaster. Backup of data can be impacted due to insecure storage or insecure configuration.

According to Advanced Materials Research (2011), back is important issue whether the cloud provider has the capability to back up the data and do complete restoration of the data in case of disaster. It can be true disaster if the cloud provider is inadequate to replicate the data and application infrastructure.
Other issue which is identified is the long term viability, it's almost isn't a fact that cloud provider will go burst, but if the accident happens it will be really very difficult for customer to get back the data .

2.8.1.14 Identity management and sign-on process

Identity management is a broad administrative area which administers the service such as authentication, identifying individuals, controlling the user access and placing restrictions.

According to Advanced Materials Research (2011), sensitive data processed by other organizations brings high risk to cloud customers, because of the outsourced services bypassing physical, logical and personnel controls.

2.8.2   Security issues in PaaS

According to Journal of Network and Computer applications 34(2011), security below the application level is in the network provider's scope and hence the provider must provide solid measures so that data remains accessible between applications. Also PaaS doesn't have the ability to segment ESB (Enterprise Service bus), which is helpful in accessing the effectiveness of the application security programs. There is a danger from hackers on the infrastructure of application. Other issues associated are with machine-to-machine Service oriented architecture (SOA) applications which are been rapidly deployed in the cloud.

According to Morsy et al. (2010), IaaS security issues can be categorized as:

SOA security issues: As the PaaS model is based on Service oriented architecture (SOA) model; it will inherit all the security issues of SOA such as DOS attacks, dictionary attacks, XML related attacks.

API security: PaaS offers APIs for performing functions such as business, security, application management. These API are vulnerable, and need to be provided with some controls.

According to NIST, PaaS clouds share the same issues as concerned with SaaS:

- Browser –based risks and risk remediation
- Network dependence
- Isolation vs. Efficiency

Lack of portability between PaaS clouds: Portability is an issue in PaaS particularly when new applications are built. During the implementation of new platforms maybe one platform's file system, queue system or hash table system may not be compatible with another. Developers may mitigate this risk by developing generalized interfaces instead of creating specialized which may incur cost which will likely limit the provider specific value added features.

Event based Processor Scheduling: PaaS applications can be event driven and use HTTP message system, which is cost effective, and few resources are consumed. However it poses resource constraint i.e. they must answer a particular call in a given time interval or they must continue a long running request by queuing synthetic messages.

Security engineering of PaaS applications: PaaS applications can run in multiple environments and access network intrinsically. PaaS applications must explicitly use cryptography

2.8.3   Security issues in IaaS

According to Journal of Network and Computer applications (2011), Public clouds pose greater risk than private clouds.

According to Ristenpart et al. (2009) Infrastructure not only pertains to the hardware where data is processed but also consists of the path to where it is getting transferred. There is a possibility data could be routed through other third party infrastructure vendor which may be intruders. As the cloud is built on internet, all the underlying threats to internet are posed by the cloud. The basis of cloud computing is that information gets transmitted over internet, even if enormous amount of security is placed, the security concerns threating internet will also threaten the cloud and risk are high. Risk is high due to the fact of the asset value of the resources residing on the cloud and their nature.

According to Meinel et al.(2010) IaaS components are Service Level Agreement (SLA), Utility computing, cloud software, Platform Virtualization, Networks and security and computer hardware.

The following are the threats categorized by Meinel et al (2010).

Service Level Agreement (SLA): The main threat can be monitoring and enforcing SLA, Monitor QoS attributes.

Utility Computing: Measuring and billing with multiple levels of providers and On demand billing system availability.

Cloud Software: Attack against XML by malicious users or attacks against web services.

Network and internet connectivity: IP spoofing, Port Scanning, DNS security

Virtualization: Security threat from Virtual machines, communications between VMs and host,

Computer hardware: Threat of physical attack against computer hardware, data security on retired or replaced storage devices.

According to Morsy et al. (2010), IaaS security issues can be categorized as:

- VM Security: There can threats to virtual machines operating systems similarly to traditional physical servers, such as malware, viruses.

- VM images repository: VM can be at risk when they offline, the security can be compromised by injecting malicious codes or the VM file can be stolen. Other security issue in VM is the templates that may retain original owner information which can be used by a new customer.
- Virtual Network Security: In cloud computing the network infrastructure is shared among different tenants with the same physical network or servers will possible exploit vulnerabilities in DNS servers, DHCP, IP protocol, or switch software which can lead to network based attacks.
- Hypervisor security: a hypervisor maps physical server to virtual resources and controls the access to the physical server resources. If there is any compromise in the security of VM then all VM operations become unencrypted.

According to Velev and Zlateva (2011), the service providers of IaaS treat the applications within the customer virtual domain as black box and not completely with the operation and management of applications of the customer. When looking at network security it is important to distinguish between public clouds and private clouds .Private clouds don't have the possibility of attacks, vulnerability or changes in risk specific to topology. In Public clouds security requirements will require to change network topology and it interacts with the network topology of the service provider. The risk associated are : confidentiality and integrity of organizations data passage to and from public cloud; proper access control; availability of internet facing resources in a public cloud and also being used by organization; replacing the established model of network zones.

Tsai et al. categorizes security issues in IaaS model into Security of Server and database, network security, user authentication, data security on the cloud side.

3 Methodology

This dissertation is written towards Cloud Computing and its emergence as cost effective computing solution. However Cloud computing has some security issues which are been looked aggressively and worked on to get full proof solutions by some big IT vendors and other specialized software companies. The project is undertaken as my interest's matches with larger concerns of the project as it was dealing with the security issues in Cloud computing service models.

To be able to gather detailed information on the Cloud Computing and security issues facing, this study has been done using a mixture of research methods. This chapter details the research methodology adopted, data collected and limitations.

3.1 Research Methods

The study employs a combination of primary and secondary data techniques .Data was collected through interview with a Senior Consultant with a big IT Consultancy company. Interview provides the opportunity to get in depth knowledge of the subject and explain the points in depth. It provides an opportunity to build relationship with the interviewee.

3.2 Data Source

In order to identify the solutions available in service models of cloud computing various reports of Gartner, IDC were used. Companies Web pages were accessed to understand about the products and service been offered by cloud providers.

3.3 Access

To gain the understanding of cloud computing, security issues and how IT vendors are working towards resolving them it was decided to communicate with one of the big IT vendors through emails or telephone as and when required. All the communications was done in July/August 2011.

3.4 Data Collection

The communication over the phone lasted between one hour to two hours, allowing good amount of time to discuss in detail. Time was not a constraint as the meeting time was communicated in advance. Mails were exchanged regarding topic and information was shared.

3.5 Limitations

The approach adopted has some drawbacks: Sometimes communication on the telephone hinder in understanding the original question itself or the solution been discussed. Data related to some of solutions been proposed were not clear but nevertheless it gave a good idea how cloud computing issues are been resolved.

4   Analysis

The following are some reports by IDC and Gartner about the market size and potential of Cloud Computing:

IDC: IDC recent market research shows public IT cloud services exceeded $16 billion in the year 2009 and by 2014 it will reach $55.5 billion, representing a compound annual growth of 27.4%. This growth is almost five times over the projected growth for traditional IT products. Recent economic downturn and uncertainty still remaining about this downturn organizations have started to amplify of adoption of cloud computing because of its cost efficiency.

Gartner: Gartner predicts Cloud computing market revenues to be reaching $148 billion by 2014.
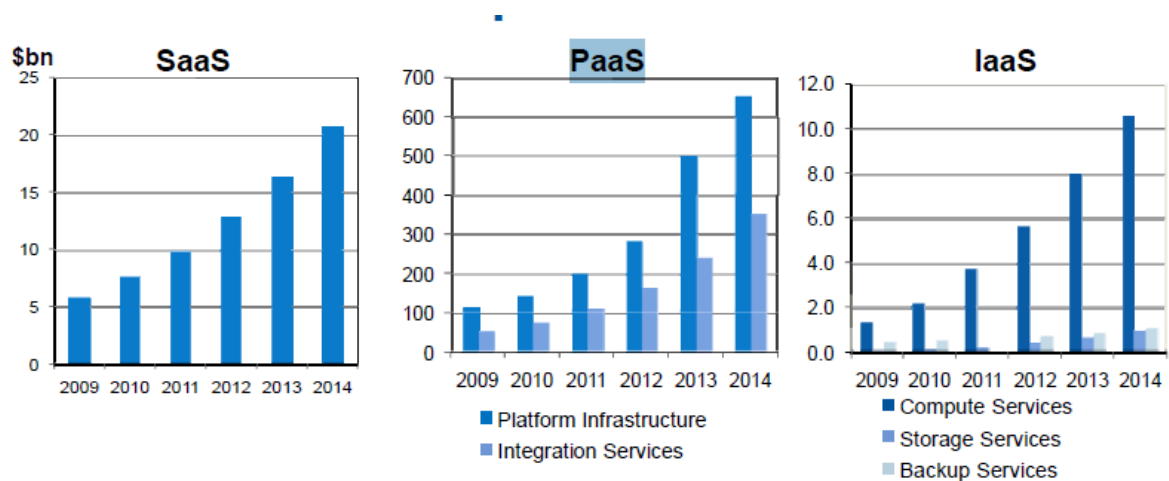
(Source: Gartner Research IT Outsourcing Trends: Tips to shape your Strategy)

The following tables show different solution available for the service models from solution providers.

Table 4.1: The following table shows different solution providers in Cloud Computing Service models:

SaaS Solution Providers	PaaS Solution providers	IaaS Solution Providers
Accenture	Google App engine	Amazon
Amazon	Force.com	AT&T
Wipro	Amazon EC2	CSC (Computer Science Corporation)

IBM	Oracle	Go Grid				
Intel	Apprenda	Rackspace				
Salesforce.com	Microsoft	IBM				
	IBM	Savvis				
		Terremark Worldwide				
		Verizon Business				

Table 4.2: The following table shows the different software solution available in Service Models, Security and top companies in Cloud Computing.

SaaS Cloud Software	PaaS Cloud Software	IaaS Cloud Software	Cloud Solution Providers	Cloud Security	Cloud Data	Top Cloud Companies
Cloud Office	GOOGLE Apps Engine	Cloud storage	Public Clouds	Data Protection	Cloud Videos	Google Cloud
Cloud Word	Sales force	Cloud hosting	Private Clouds	Identity Management	Cloud Images	Microsoft Cloud
Cloud Excel	AMAZON EC2	Cloud server		Physical Security	Cloud News	IBM Cloud
Cloud PPT	Oracle	Cloud Print		Application Security	Cloud Books	HP Cloud
Cloud SharePoint	Microsoft	Cloud backup		Data Recovery		SAP Cloud
Cloud Management		Cloud database				SUN cloud
Cloud Accounting		Free cloud storage				VMware Cloud
Cloud ERP		Cloud host				Amazon

					Cloud
Cloud CRM		Cloud VPS			Sales force Cloud
Cloud SCM		Free Cloud Hosting			INTEL Cloud
Cloud PDM		Cloud reseller			
Cloud PLM		Cloud VPN			
Cloud EAM					
Cloud HR					
Cloud Anti-virus					
Cloud conference					
Cloud email					
Cloud MAP					
Cloud browser					
Cloud GAME					

4.1 Solutions for SaaS (Software as a service) Service Model

Accenture: Accenture has SaaS business suite solution which can be used across strategy and planning, execution and operation. Accenture business suite helps organizations to access and plan their strategies and integrate SaaS solutions with existing systems in complex, global environment. It addresses business issues in human resources, customer service, indirect and direct sales and back office solutions.

Accenture has developed alliance with different software vendor in the space of cloud computing for providing powerful solutions .This helps Accenture to provide complete range of solutions to business which help client to achieve sustainable "*IT cost reduction, reduced total cost of ownership, reduced delivery risk, and accelerated vendor identification and evaluation cycle time*"(Accenture,2011).

List of key Alliances:

Eloqua: Accenture and Eloqua jointly develop SaaS based solutions in "*customer relationship management, demand generation, marketing automation and lead management*" (Accenture, 2011).

Microsoft : Accenture and Avande,business technology service provider is using Microsoft platform to help enterprises to achieve growth, reducing cost and delivering cloud computing solution on the Windows Azure platform which helps to improve performance and reduce costs. This team offers clients market leading SaaS and cloud vision technologies.

Salesforce.com: Accenture and salesforce.com are a one-stop source for large global enterprises that need to define and implement cloud-based solutions across the entire organization. The Alliance has a six-year track record of delivering agile, enterprise-scale, software as a service (SaaS) and cloud-based computing solutions that deliver greater productivity, revenues and ROI, and greater customer satisfaction.

Amazon: Amazon has PayGo SaaS product in its Amazon Elastic Cloud portfolio for Software as as service offering. The product is designed for retail business based on the powerful computing environment.

IBM: IBM offers Cloudburst as one of the prepackaged and self-contained service delivery platform that can be easily implemented providing a complete hardware and software solution. The essential features this project features:

- Self-service portal for reservation of storage ,compute and networking resources
- Automated provisioning of commissioning and decommissioning of resources
- Service management for cloud computing
- Real time monitoring for cloud computing
- Energy management

Salesforce.com: Salesforce.com has different products in SaaS portfolio which are easy to deploy and manage and customable to the business requirements .Saleforce.com SaaS product offers scalability, flexibility and easily upgradeable when the business grows. Some of the products offered by Salesforce.com are: Sales cloud, Service Cloud Jigsaw and others.

Wipro: Wipro offers services such as " *IT advisory, consulting services to business, system integration, application development, application development, and cloud migration services*". Wipro offers cloud solutions in SaaS domain and offers:

- Help and build private cloud computing environment

- Help customers adopt and build cloud application into IT portfolio and manage IT systems

- Offer Wipro Cloud product portfolio to customers

Wipro major product offers in SaaS is called w-SaaS, platform for rapid SaaS enablement an deployment on cloud, it chose Oracle database, Oracle web logic application server, and Oracle VM as the deployment platform for its w-SaaS applications.

Wipro has filed patent for this product which will help in privacy and confidentiality.

Wipro has a strong R&D to focus on innovation of new products such as Cloud which positions itself as a strong player in cloud computing.

SaaS (Software as a Service) Solution Available in Industry for specific Security issues:

Data Security

Intel: Intel has introduced its new microprocessors called Intel AES New instructions (Intel AES-NI) help to reduce encryption overhead which in turn makes pervasive encryption possible for all IT business critical data and ultimately help secure the entire enterprise.

Network Security

IBM Managed security services (Cloud computing)-hosted vulnerability management can detect vulnerabilities across network devices, servers, web applications and database servers to reduce risk and attacks. The Managed Security services not only reduce risk but also classify and prioritize vulnerabilities.

4.2   Solutions for PaaS (Platform as a service) Service Model

Amazon

Amazon Elastic compute cloud (Amazon EC2) provides resizable compute capacity and makes web scale computing easier for the developers.EC2 allows integrating with interfaces easily and provides a complete control of customer computing resources which is run on Amazon's computing environment. Amazon EC2 reduces time to boot new servers, scale up fast both up and down. Amazon EC2 charges only for the capacity that is actually used. Amazon's EC2 is flexible in the choice of multiple instances, operating systems, and software packages. It allows the users to choose the required configuration of memory, CPU, storage, boot partition size that is optimal for the

applications and operating system. Amazon EC2 provides various mechanisms for securing the computing resources.

Apprenda

Apprenda is private PaaS solution provider and operate in public or within customer datacenter environments .It specializes in accessible foundation to Microsoft.NET web and SOA apps in enterprise IT portfolio. Apprenda is capable of integrating any number of load balancers, Windows Server, SQL server and IIS assets into a single multi-tenant resource pool.

Key Benefits:

- Reduce application time from 30 days to 15 minutes
- Standardize application deployment time by almost eliminating specific configuration and hardware requirements
- Boost infrastructure up to 10x beyond what virtualization provides through shared tenancy
- Cost Efficient Infrastructure investments in hardware, virtualization, system management, monitoring, analytics, and backup tools.
- Advanced Data Scooping to access both granular and aggregate data across the deployment environment and user access point providing reporting and business control over entire aspect of application portfolio.

Cloud Foundry: CloundFoundry is the world's first open platform as a service offering based on VMware .It gives a platform for building, deploying and running cloud applications using spring for "*Java developers, Rails and Sinatara for Ruby developers, Node.js and other JVM languages/framework including Groovy, Grails and Scala*" (CloudFoundry,2010).

Cloud Foundry provides a multi-tenant PaaS that runs on industry leading vSphere cloud platform. It has products such as Cloudfoundry.org and Micro Cloud Foundry which gives the developers a platform to join forces and contribute to the project. Cloud Foundry easily integrates with various development tools and deployment processes and open architecture for quick development framework integration, application services interface and cloud provider interface.

Google App Engine: Google App Engine is a platform for developing and hosting web applications and its first version was released in 2008.Googe App engine is cloud computing technology and is based on the principle of virtualization. Its main competitors are Amazon Web services and Microsoft Azure Services platform. Google app engine is free up to certain number of users but after that threshold it charges for additional storage, bandwidth or CPU cycles required by the application.

Google App Engine supports programming languages such as Python and Java. Google has plans of supporting more languages in near future.

Google PaaS solution is available to Small Business, Medium Business and enterprise. At present three (3) million businesses are using the Google solution. Google offers simple, powerful communications and collaboration tools for all kind of businesses to streamline setup, minimize maintenance, and reduce costs. Google offers simultaneous edit of various applications .Google Apps makes simple for IT administrators as they don't have to do any routine task.

Some Salient features of Google Apps are:

- User managed groups take burden off IT, by self-assembling and managing their own workgroups
- Complex organizations with multiple domains can still work like an interconnected unit with multi domain management which helps the process of spreading and sharing the information between people across organization with no any form of barriers.
- Google App supports Android technology and seamlessly integrates with iOS devices, Windows mobile devices, Blackberry devices.
- Google Apps mobile device management allows IT administrators to enforce mobile password requirements, remotely lock devices, and even wipe devices over the air.
- Google provides 99.9% uptime SLA guarantee and 24X7 phone and online support.

Compared to other competitor products such as Amazon EC2, Google app engine provides more scalability in infrastructure.App engine overcomes removes many of the challenges such as system administration and network bottlenecks which are required to scale hundreds of request per second and beyond.

Developers fear of being locked in the technology, but Google has started with number of projects related to open source back ends, APIs, database APIs; but all of these projects are various levels of maturity and none of them are at the stage where they can be installed and deployed.

Microsoft

Microsoft has Windows Azure offering for Platform as a service model. Windows Azure gives the empowerment to run applications with ease of scalability and ease of use. This service model provides ease of scaling up or down as per the business requiremnets.Windows Azure allows developers to build and run applications quickly while leveraging skills to develop applications with .NET, PHP or JAVA.

Microsoft provides comprehensive end-to-end cloud solution.

Developers don't need to learn new techniques; Windows Azure provides the environment of easy integration of existing applications and creates new web applications and services using familiar tools.

Windows Azure gives the flexibility to take advantage of multiple development tools, programming languages, automate service management, and global data center presence to deliver applications and services faster. This gives competitive advantage and help customers to reach new targets.

Windows Azure gives the flexibility of how to manage, deploy, store data, which allows the customer to focus more on business challenges and their customer needs.

Windows Azure consists of risk based program which captures security threats and operational issues and keeping updated security control mechanisms and maintaining them as well.

Windows Azure gives 99.9% uptime guarantee and includes 24/7 support.

Windows has other cloud platform solutions in this product portfolio: Microsoft SQL Azure, Microsoft Azure App fabric, Microsoft Azure for developers.

Sales force

Sales force PaaS product is known as Force.com platform. The platform allows external developers to create applications which can be integrated into Sales force platform and then can be run on Sale force infrastructure.

Force.com platform is a cloud computing platform that developers use to build multi-tenant applications hosted on their server as a service.Force.com implemented by more than 1000 customers as per Gartner's September 2009 report which is run across eight data centers, with each customer fully contained in single data center that is replicated for availability.

Platform has been described as strong potential but only applicable for customers who want to extend their product portfolio from Salesforce.com to Force.com.

Oracle

Oracle Platform as a service (PaaS) provides a shared and elastically scalable platform for consolidation of previous and new developments and their deployment. Oracle PaaS offer cost optimization and higher utilization across multiple application .Oracle PaaS includes Oracle database

services such as Oracle Database and Oracle Exadata as well as middleware services based on Oracle Fusion middleware and Oracle Exalogic Elastic Cloud.

Oracle PaaS benefits:

Efficiency: Oracle PaaS increases asset utilization, shared application platform, and reducing complexity and time to market.

Scalable: Oracle leading technologies on virtualization and clustering provides the elastic capacity on demand required by PaaS environment.

Secure: Built in security features in Oracle database and Fusion Middleware enable a PaaS computing model to comply with stringent security, privacy and regulatory requirements**.**

Extreme performance: Oracle products have unparalled speed and highest consolidation efficiency in Industry.

Comprehensive: Oracle PaaS product portfolio consists of cloud application development and deployment, cloud management, cloud security, and cloud integration.

4.3   Solutions for IaaS (Infrastructure as a service) Service Model

Amazon: is a cloud IaaS focused vendor .Its highly automated, commodity infrastructure, without any commitment to contract. Their major products are Elastic Compute Cloud (EC2), cloud CDN and number of PaaS services.

- Amazon is innovative, agile and responsive to the market. It has vast product portfolio and constantly innovating and reducing prices.
- Amazon has tightly integrated ecosystem, many software vendors have packaged their software's on EC2.
- Amazon provides full access to its infrastructure.
- Amazon has largest pool of capacity, which makes it few infrastructure providers to support 'bursty' workloads, such as scientific computing, modeling, simulation.
- Amazon doesn't offer managed services, as it is in the process of expanding service portfolio, this offers only some aspects to be automated such as Relational Database Service for MySQL. However these services do not provide the basic functions of lightly managed IaaS.
- Amazon is the only vendor not providing standard options of colocation, dedicated non virtualized servers, private non internet connectivity.

- Amazon has the weakest cloud compute SLA of any computed public cloud compute services.
- Amazon is the price leader but charges separately for optional items. This makes it difficult for customers as these services add 10%-20% additional cost.
- Amazon is offering developer centric rather than enterprise centric.

AT & T

AT & T is a global telecommunications leader; it offers colocation, managed hosting on dedicated hardware. It offers VM based Synaptic Hosting platform, cloud IaaS on its Compute as a service (CaaS) platform, cloud storage and a CDN.

- AT & T has a strong commitment towards cloud computing and has a clear roadmap ahead. Its roadmap is tightly integrated with its network services which give a competitive edge over others.
- AT & T is a leader in complex managed hosting with a strong technical expertise and good customer portal.
- AT & T synaptic platforms are acquired from US and application hosting provider which is now tightly integrated into AT & T.It has extensive experience in complex enterprise applications in virtualized environments.
- Sales process for AT & T hosting services is slow and complex which turns out to be difficult for the customer's .However the sales service for Synaptic CaaS is quick.
- Customers need to see if they are using non AT & T network, AT & T should have contract with the network operator.

CSC (Computer Science Corporation)

CSC is large IT organization with large IT capabilities. It offers managed hosting, VMware based cloud IaaS.

- Cloud computing is helping CSC to reinvent the way it does business with its customers by offering cost effective solutions.
- CSC has made its solutions around a commonplace making it easy to fit customer needs.
- CSC offers Skytap which offers significant value to developers beyond just raw infrastructure. Skytap supports features such as direct integration with integrated development environment (IDEs), complex network simulation and the ability to snapshoot the state of multimachine configurations for defect-replication purposes.

- CSC has large portfolio of product offerings, but is mainly focuses on traditional enterprise.
- CSC portfolio of products is innovative and new but is unproven in the market.
- CSC service and support has been a weakness, quality of account management is highly variable.
- CSC is using Virtual computing environment architecture (VCE) which is potentially higher cost, not higher reliability or security.

Go Grid

Go Grid is a small IaaS player with focus on Xen Based cloud IaaS service. It offers public cloud, private cloud and as on premises software. Its product portfolio also has colocation and managed hosting.

- Go Grid successfully blends commodity priced IaaS with hybrid services.GoGrid offers all the managed services in conjunction with it cloud, while most managed hosters offers only a subset of their managed and professional services.
- GoGrid has industry leading SLAs along with enterprise class service and support.
- Go Grid offers various payment options such as "pay by the hour with a credit card" and traditional enterprise contracts.
- GoGrid software is developed in-house which leaves the scope of innovation, scalability, up gradation quickly which brings down the cost. But this also has long term challenges in competing as other players can devote significant resources to R& D.
- Go Grid offers individual user accounts, it doesn't support hierarchical role based mapping. Customers who want this need to deploy their own virtual management lab software.
- GoGrid is Xen based provider but its target market includes enterprises which are primarily VMware based and may want cloud Director Support.
- Gogrid has its own API supported by limited number of vendors, although it's pursuing a strategy of broader interoperability.
- Although GoGrid has significant international business its cloud is not deployed in Clouds outside US.

IBM

IBM is highly diversified and one if the largest companies and its cloud computing strategy extends across its portfolio of products and services. It offers colocation, managed hosting and cloud IaaS.

- IBM uses it utility computing management, called Managed Services Infrastructure Services as the foundation for both its managed services and its application management portfolio. It also offers on-demand options for disaster recovery.
- IBM IaaS is sold as use-case specific way. The Smart business development and test cloud service is integrated with Rational and Tivoli tools. The computing on demand is aimed at customers with supercomputing needs.
- IBM has a range of services related to cloud computing such as assessment, planning and migration services.
- IBM leverages it technology portfolio when delivering cloud computing solutions without restricting customers to use only IBM technologies.
- IBM cloud computing strategy is more focused on SaaS, and enabling customers to build clouds of their own, rather than focusing on IaaS, but it's highly visible in the market due to IBMs strength as a vendor. IBM is currently exploring the market where it is going before committing on IaaS based strategy only.
- IBM is focused on cloud IaaS that bring higher value by tight coupling them with its own products.IBM IaaS is targeted at test and development and supercomputing and are not good fit for customers with general purpose computing needs.
- IBM offers high end hosting services and for upmarket customers. Its hosting deals closely resemble more general data center outsourcing deals. Its suitable for largest most complex and customized deals(equivalent to 50 servers or more) .IBM uses partners to deliver solutions to smaller managed services increasing issue of communication, quality , these customers are not delivered by IBM but the solutions are architected by IBM .
- IBM is premium priced typically far above the competitors.Morever it sells managed services rather than all inclusive services basis.IBM hosting contracts are quite lengthy and complex and increase the risk on the client and away from IBM .IBMs basic SLA for hosting is weak and better SLAs generally cost more money .

Rackspace

Rackspace is an independent Web hoster and market leader in managed services. It product portfolio consists of Rackspace Managed, Rackspace Intensive and Xen based cloud IaaS. It also has a PHP and .NET based cloud PaaS (Cloud sites formerly known as Mosso), email and SharePoint sharing, cloud storage and cloud based backup (JungleeDisk).

- Rackspace has set high standard of customer service with its proactive, high touch service and support. It has the industry best practices in customer services along with excellent service culture.

- Rackspace is highly responsive towards sales process and has reliable service installation. It does good solutions engineering and delivery.

- Rackspace pricing for complex managed services are below market average. For other services it's comparable with the market offerings.

- Rackspace has "open sourced" its cloud development, via the Open stack project. This will help Rackspace in building an ecosystem around its cloud.

- Rackspace cloud IaaS is not yet enterprise class; it lags behind its two competitors Amazon and GoGrid. Futher it's a Xen based provider but its target market includes enterprises which are primarily VMware based .

- Rackspace is best handling Web centric environments rather than traditional enterprise applications (ERP).

- Rackspace doesn't offer utility hosting. It does offer Rackspace Private Cloud where dedicated servers are virtualized with VMware, where customers pay a flat fees and usage fees.

- Rackspace cloud offerings are different from managed hosting. Its service approach differs between its managed and intensive service levels and its cloud division. It has started doing hybridization (Cloud Connect) for customers who have both cloud servers and dedicated servers.

Savvis

 Savvis is an independent Web hoster with leadership in colocation and managed hosting (including utility hosting of its virtual Intelligent hosting platform) .Product portfolio consists of VMware-based IaaS, proximity hosting and network services.

- Savvis product portfolio is one of the broadest and deepest in the industry and strongly technically supported. It has a diverse range of IaaS products and also has several options in private and public clouds.

- Savvis is highly competent in solution engineering with capacity of scalability. It's a leader in managing large complex customers, with high rates of change, and executing large scale servers typically more than 50 servers.

- Customer support portal is one of the best in the industry.

- Savvis service delivery and support are above average and customer support for large complex projects is improving with time.
- Savvis product range can confuse the customer and sales force.
- Savvis has not fully integrated its cloud offering with its managed services.
- Savvis has built an enterprise with very strong security features but its offering is more expensive than its competitors.
- Savvis products are priced in the premium range.

Terremark Worldwide

Terremark Worldwide is an independent Web hoster offering colocation, managed hosting, developer centric public cloud IaaS and enterprise-class cloud IaaS.
- Terremark is high in innovation and very effective in exploiting technology.
- Terremark is a close VMware partner and is first to market VMware based solutions.
- Terremark is strong in public sector such as civil and defense agencies. It has invested in providing compliance and audit solutions.
- Terremark has presence in some geography where its competitors are not able to service such as South America.
- Terremark pricing is average and it allows oversubscription and resource bursting which helps customers in effective utilization of the IaaS.
- Terremark service was good at one point but now customers complain sales person seem overcommitted and as a result they no longer deliver on the time and are not reliable.
- Terremark has been associated in taking cutting edge technology and unusual configurations, however Terremark is saying No to customer requirements.
- Terremark's highly leveraged balance sheet and its focus on spending on expanding colocations resources are inhibiting product portfolio investment growth and may be contributing to service woes.

Verizon Business

Verizon is one of the biggest telecommunication providers, offering colocation; managed hosting and cloud IaaS on its VMware based computing as a service (CaaS) platform.
- Verizon revitalized its business in mid-2009 by introduction of CaaS (Computing as a service).

- Verizon is certified vCloud Datacenter provider, however there are two CaaS platforms: launched in 2009 and newly launched that supports vCloud Director.

- Multiple tiers of SLA can support a variety of application requirements.

- Account Management is based on the level of change on a customer's environment.

- Verizon is in the middle of changes in sales, support, processes, service oriented architecture.

- Customer's satisfaction for CaaS is much higher than customer satisfaction with Verizon's traditional managed hosting.

- Verizon's pricing is very competitive but its traditional managed hosting is premium priced.

5 Discussion

The section covers the ideas which have come up during analysis of cloud computing solution or offering .The main higher level theme has been categorized as:

5.1 Data Recovery:

Cloud computing is a disruptive innovation and is changing computing world rapidly. By the introduction of various Cloud computing models such as Public Clouds, Private Clouds, Hybrid Cloud and service models such as Infrastructure as a service(IaaS),Platform as a Service(PaaS),Software as Service(SaaS),no doubt Cloud computing has been able to bring down the capital cost as well as running cost to a larger extent .Cloud computing has been able to help startups and other Small medium Enterprises (SME) which are not having adequate budget to support their extensive IT plan, but cloud computing offers SME to benefit from scalable infrastructure.IT vendors are able to offer various cost efficient cloud solutions, but still there is a scope to improvement in Data Recovery process , in case of any disaster happens like fire. What happens if the data center of any of the service models or deployment models crash? This will have an impact on SME as they would not like to spend any additional expenses from the budget. However work is still going on making data recovery process more efficient.

Big reputed cloud service providers such as Oracle, Salesforce.com, Amazon, IBM and others are making robust data recovery and lot of work development is taking place.

5.2 Financial Aspects:

Due to economic turmoil in world economy which is being witnessed for last 4-5 years now, companies are reducing their IT budgets, companies are filtering processes which are necessary for the business to sustain and run. In this scenario Cloud computing will play a big role for these companies. Cloud computing offers pay as you go model, which translates into lower cost. Cloud

computing is better for startup or Small medium companies (SME), but analysis need to be done regarding break even analysis and how fast SME will be able to cover the cost .

5.3   Utility Companies:

Utility companies such as Electricity, Water are still using conventional IT solutions keeping the entire IT infrastructure within their boundary .Because of high cost associated with this kind of maintenance and also it effects in their budget. As Nonrenewable resources becoming expensive day by day and these companies feeling the heat. Tomorrow if the firms start deploying Cloud computing solution, can these models sustain or support the kind of data these companies have. It must be taken in note data is very important for these companies, as it contains confidential data about the consumers such as Name, Address details, financial details and also credit history. Since in terms of security lot of development and enhancement work is still going in Cloud computing what if some transaction data falls into hackers, it can be disastrous both for firm and consumers. It has to be seen how data of millions of consumers (which can run in billions of gigabytes) can be stored using cloud computing models effectively keeping issues such as privacy , confidentiality into account.

5.4   Turnaround Time/Downtime/Outage:

In any industry Turnaround or Downtime it is an important parameter in distinguishing the firm in the market place. It is how fast a business can be brought back to normalcy in case of any issue happening/enhancement/planned patch implementation. Conventional solution give tremendous amount of importance to this parameter and keep it in SLA's.The firms with good turnaround are normally the ones which rule the market .Players such as Oracle, SAP ,VERITAS have high turnaround time for their products which have made them market leaders in their respective industries. Also these companies have shaped the businesses by arming them with business competiveness over their rivals. To be successful and make such an impact, Cloud computing solutions need to clearly come up with the strategy for downtime which should be minimal and affect the business to the minimal. For example consumer industry which is fast moving, data plays an important role as it has got demographic data and other details which are important to marketing, if this data is kept using cloud computing solution and a disaster happens at the data center .Consumer company will lose all its data which will have an impact on the business, but if turnaround time is fast will be better for business. From this example if the cloud computing disaster recovery should be secured and privacy is maintained.

5.5   Annual Maintenance Contracts/Maintenance Expenses:

Annual Maintenance plays an important role for the business to keep it running and good maintenance differentiates from other businesses. Annual Maintenance plays an important role in

budgets. Conventionally firms implement best solution available in the market to suit their business; simultaneously they spend a good percentage of their budget on IT. This makes cost high for firms and in turn tries to cut spending on maintenance contracts. Nevertheless cloud computing will prove to be cost efficient computing model, but still it's not much clear how Annual Maintenance contracts work for cloud computing model ,especially if firm wants to implement private cloud for their business. For example a firm having million customers goes on cloud computing model, it needs to be seen how cloud computing maintenance will work, as newer technologies come rapidly and firm invest in those technologies, and would require them to integrate with already technologies. One of important point to be noted is how easily cloud computing will be scalable or to integrate with these newer technologies will differentiate from other computing models or solutions available in the marketplace.

5.6 Insurance:

Organizations have Insurance cover for almost all of their computing resources , but it needs to be seen how in cloud computing insurance cover will happen if some disaster happens at the data center. In a scenario a firm implements a cloud computing solution and keeps all the data at the cloud provider's data center. Cloud providers Data Center will be having insurance cover but not sure whether the customer's data will also be covered in that insurance .If some crash happens or natural calamity strikes, the cloud computing provider will be able to take insurance but what will happen to customer? As the data is lost in this case with time it needs to be seen how customer will be insured.

5.7 Licensing:

Enterprise Resource Planning have ideology of user license, it needs to be seen how cloud computing will implement the license in the computing model. These licenses have strict clause of confidentiality, it will be of interest how Vendor, Business Firm and Cloud computing vendor will work regarding licensing. This will involve tri-party agreement which will cover sensitive points such as privacy, confidentiality, scope of user management.

5.8 Governance Model:

Cloud computing model has thousands of services and data elements under one management which need control how they should be accessed, added, deleted, and altered. Thus there should be an approach, processes, procedures and technology.

5.9 User friendliness:

Cloud solutions & models are relatively more user friendly & hence after the implementation it is relatively easy to do the change management & train existing resources [super users & end users]

into the new technology. In turn, investment in training is going to be less. This will help making the solution more acceptable & adoptable to the user's community.

6 Conclusion

Security & Privacy: Big Vendors are working hard to secure the clouds by offering private cloud architecture. Data is the important entity in any organization, security and privacy are very vital to it.Several ways are been implemented to secure data such as encryption techniques. Research is going on to build a model which will be dynamic and localized in nature.

Financial Aspect : Considering the fact about the global economy and organizations ever decreasing IT budget by exponential rate cloud computing will play a major role in giving 'less for more' . For Small medium enterprises Cloud computing will tend to be cost effective and support their plan of effective IT infrastructure. Disregarding of the size cloud computing may provide business benefit in an optimal way and help in the reduction of IT budget.

Annual Maintenance: Like Annual Maintenance Contract which run into long years, cloud computing solution will be a long term solution, as it will be easier to implement and scalable . However it will be of importance how easily cloud computing can integrate with other new platform's or technologies.

7   Recommendations

For any organization or Small Medium Enterprise, IT strategy is very critical for a business to be successful or gain competitive advantage over its competitors. The Firm must check whether the IT solution will fit into the business vision and how much critical it can be to the firm. The business must evaluate parameter such as IT staff, costs, complexity of IT solution; maintenance before finalizing a solution and how important is to keep the data center within organization boundary. Cloud computing can be effective in reducing the IT budget to a larger extent especially in the case of Small Medium Enterprises.

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