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A Comprehensive Study on Cloud Computing

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Abstract— Cloud computing is becoming an increasingly popular enterprise model in which computing resources are made available on-demand to the user as needed. The unique value proposition of cloud computing creates new opportunities to align IT and business goals. Cloud computing use the internet technologies for delivery of IT-Enabled capabilities 'as a service' to any needed users i.e. through cloud computing we can access anything that we want from anywhere to any computer without worrying about anything like about their storage, cost, management and so on. In this paper we provide a comprehensive study on the motivation factors of adopting cloud computing, review the several cloud deployment and service models. It also explore certain benefits of cloud computing over traditional IT service environment-including scalability, flexibility, reduced capital and higher resource utilization - are considered as adoption reasons for cloud computing environment. We also include security, privacy, internet dependency and availability as avoidance issues. The later includes vertical scalability as technical challenge in cloud environment.

Keywords— Cloud Computing, Cloud Services, Scalability, Vertical Scaling, Virtualization.

I. INTRODUCTION

Traditional application integration technologies are performed in a rigid and slow process that usually takes a long time to build and deploy, requiring professional developers and domain experts. They are server-centric and thus do not fully utilize the computing power and storage capability of client systems. Since the face of the Internet is continually changing, as new services and novel applications appear and become globally noteworthy at an increasing pace. Nowadays the locus of computation is changing, with functions migrating to remote datacenters via Internet based communication. Computing and communication are being blended into new ways of using networked computing systems. Next generation networks and service infrastructures should overcome the scalability, flexibility, resilience and security bottlenecks of current network and service architectures, in order to provide a large variety of services and opportunities, adoptable by business models capable of dynamic and seamless utilization of IT resources based on user-demand across a multiplicity of devices, networks, providers, service domains and social and business processes [1].

An Envisioning the computing utility based on the service provisioning model, where resources are readily available on demand, has led to contemporary computing paradigms that have emerged in the last decade, exploiting technological advances in networked computing environments e.g. GRID computing, peer to peer computing and more recently cloud computing [2]. Figure-1 shows the result as Cloud Computing from Evolution process of various computing technologies. Cloud computing [3],[4],[5] is a new infrastructure deployment environment that delivers on the promise of supporting on-demand services like computation, software and data access in a flexible manner by scheduling bandwidth, storage and compute resources on the fly without required end-user knowledge of physical location and system configuration that delivers the service. According to the NIST definition [6], ―Cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud Computing is virtualized compute power and storage delivered via platform-agnostic infrastructures of abstracted hardware and software accessed over the Internet. These shared, on-demand IT resources, are created and disposed of efficiently, are dynamically scalable through a variety of programmatic interfaces and are billed variably based on measurable usage. In a traditional hosted environment, resources are allocated based on peak load requirements. In cloud computing they can be dynamically allocated.

Virtualization, in computing, is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system, a storage device or network resources. Virtualization technologies promise great opportunities for reducing energy and hardware costs through server consolidation. Moreover, virtualization can optimize resource sharing among applications hosted in different virtual machines to better meet their resource needs. As a result more and more computing can be conducted in shared resource pools that act as private and public clouds.

Figure-1: Evolution of Computing

In this paper we focus on the motivation factors of cloud computing, review the several cloud deployment and service models. It also explore certain benefits of cloud computing over traditional IT service environment-including scalability, flexibility, reduced capital and higher resource utilization -are considered as adoption reasons for cloud computing environment. We also include security, privacy, internet dependency and availability as avoidance issues. The later includes vertical scalability as technical challenge.

The rest of this paper is organized as follows: Section *II* describes the cloud computing service models and deployment models. Section *III* presents the motivation factors for accepting cloud computing and avoidance issues, also discuss vertical scaling as technical challenge. Finally, Section *IV* concludes the paper.

II. CLOUD ARCHITECTURE

All Cloud computing is a set of IT services that are provided to a customer over a network on a leased basis and with the ability to scale up or down their service requirements. Usually cloud computing services are delivered by a third party provider who owns the infrastructure. It advantages to mention but a few include scalability, resilience, flexibility, efficiency and outsourcing non-core activities. Cloud computing offers an innovative business model for organizations to adopt IT services without upfront investment. There are two basic cloud models are discussed, first the Cloud service model and the second Cloud Deployment model.

A. Cloud Service Model

Cloud computing is a delivery of computing where massively scalable IT-related capabilities are provided ―as a service across the internet to numerous external clients [7]. This term effectively reflects the different facets of the Cloud Computing paradigm which can be found at different infrastructure levels. Cloud Computing is broadly classified into three services: “IaaS", "PaaS" and "SaaS" [8]. Cloud Computing have some different utility services [9].

1) *IaaS (Infrastructure as a service) model:* The main concept behind this model is virtualization where user have virtual desktop and consumes the resources like network, storage, virtualized servers, routers and so on, supplied by cloud service provider. . Usage fees are calculated per CPU hour, data GB stored per hour, network bandwidth consumed, network infrastructure used per hour, value added services used, e.g., monitoring, auto-scaling etc. Examples: Storage services provided by AmazonS3, Amazon EBS. Computation services: AmazonEC2, Layered tech and so on.
2) *PaaS (Platform as a service) model:* It refers to the environment that provides the runtime environment, software deployment framework and component on pay to enable the direct deployment of application level assets or web applications. PaaS is a platform where software can be developed, tested and deployed. It means the entire life cycle of software can be operated on a PaaS. This service model is dedicated to application developers, testers, deployers and administrators. Examples: Google App Engine (GAE), Microsoft Azure, IBM SmartCloud, Amazon EC2, salesforce.com and jelastic.com and so on.
3) *SaaS (Software as a service)*: Through this service delivery model end users consume the software application services directly over network according to on-demand basis. For example, Gmail [10] is a SaaS where Google is the provider and we are consumers. Other well known examples of PaaS include billing services provided by Arial system, op source. Financial services: Concur, workday, Beam4d. Backup and recovery services: Jungle Disk, Zmanda cloud back up and so on.

B. Cloud Deployment Model

There are four primary cloud computing deployment models which are available to service consumer as shown in figure-2 [11].

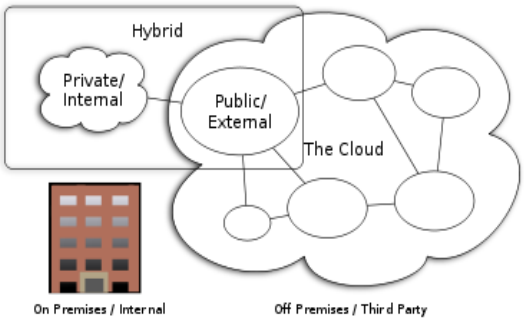

Figure-2: Types of Cloud Deployment Model

1) *Public cloud/external cloud:* This model allows cloud environment as openly or publically accessible. Public cloud is off premise in which various enterprises can be used to deliver the services to users by taking it from third party.
2) *Private cloud/internal cloud:* This model referred to on-premise cloud which is managed or owned by an organization to provide the high level control over cloud services and infrastructure. In other words private cloud is build specifically to provide the services within an organization for maintaining the security and privacy.
3) *Hybrid cloud/virtual private cloud model:* This model compromised both private and public cloud models where cloud computing environment is hosted and managed by third party (off-premise) but some dedicated resources are privately used only by an organization.
4) *Community model:* It allows the cloud computing environment which is shared or managed by number of related organizations.

III. MOTIVATING FACTORS AND CHALLENGES

Cloud systems are not just another form of resource provisioning infrastructure and in fact, have multiple opportunities from the principles for cloud infrastructures that will enable further types of applications, reduced development and provisioning time of different services. Cloud computing has particular characteristics that distinguish it from classical resource and service provisioning environments [12]:

- Infinitely (more or less) Scalable
- Cost saving/less capital expenditure
- Higher resource Utilization
- Business agility
- Disaster recovery and Back up
- Device and Location Independence

While reducing up-front IT cost or capital expenditure is the one of crucial reason for the adoption cloud computing, there are also some other factors that encourages the various organizations for the adopting the cloud computing. Participation of various factors for encouraging the adoption of cloud computing is shown in figure-3 [13].

In static resource allocation configurations there inevitably exists a trade-off between capacity deployment and resource demand. Cloud computing shifts the location of resources to the cloud to reduce the costs associated with over-provisioning (i.e. having too many resources), under-utilization (i.e. not using resources adequately) and under-provisioning (i.e. having too little resources). It also reduces the time required to provision resources to minutes, allowing applications to quickly scale under-utilization both up and down, as the workload changes. Therefore, cloud computing is particularly well suited for applications with a variable workload that experience hourly, daily, weekly or monthly variability in utilization of resources. One example of such applications is online shops, which have to handle their peak loads at Deepawali time. Another example is university websites, which have to handle their peak loads during exam result time.

In traditional (i.e. non-cloud) environments, over provisioning and under-utilization can hardly be avoided [5]. There is an observation that in many companies the average utilization of application servers ranges from 5 to 20 percent, meaning that many resources like CPU and RAM are idle at no peak times [14]. On the other hand, if the companies shrink their infrastructures to reduce over-provisioning and under-utilization, the risk of under-provisioning will increase. While the costs of over-provisioning and under-utilization can easily be calculated, the costs of under-provisioning are more difficult to calculate because under-provisioning can lead to a loss of users and zero revenues [14].

Virtualization technology is also one of the primary reasons of popularity of cloud computing because it provides a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software and virtualization technology [15],[16] play the key delivery technology. Through Virtualization cloud computing removes the dependencies between software and the hardware that runs it.

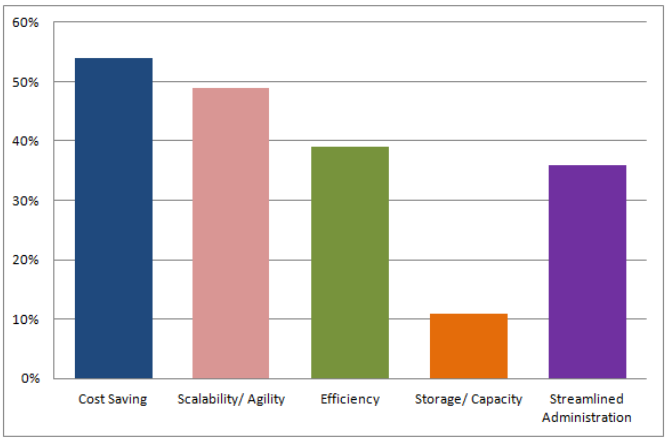

Figure-3: Partition of motivating factors for the adoption of cloud computing
Cost saving (54%), Scalability (49%), efficiency (39%), Storage (11%), streamlined Administration (36%) (Approximate values)

As we know, cloud computing has various motivating factors according to the perspective of adoption but there is still long way for cloud computing to prove itself according to the organization's trust level. There are various reasons that warns us for the adoption of cloud computing.

- *Security*

Security issue has played the most important role in hindering Cloud computing acceptance. Various security issues, possible in cloud computing are: availability, integrity, confidentiality, data access, data segregation, privacy, recovery, accountability, multi-tenancy issues and so on. Solution to various cloud security issues vary through cryptography, particularly public key infrastructure (PKI),use of multiple cloud providers, standardization of APIs, improving virtual machines support and legal support [12], [17].

- *Difficult to migrate*

It's not very easy to move the applications from an enterprise to cloud computing environment or even within different cloud computing platforms because different cloud providers support different application architectures which are also dissimilar from enterprise application architectures [12].

- *Internet dependency – performance and availability*

Cloud computing services relies fully on the availability, speed, quality and performance of internet as it works as carrier in between consumer and service provider [12].

- *Downtime and service level*

In business applications, downtime is common concern because every minute of downtime is minute in which important business application can't be performed which degrades the performance of organization as well reputation also [12].

Scalability is the best solution to increasing and maintaining application performance in cloud computing environments. But one of the main technological challenge of cloud environment is vertical scalability (Scale up) because in cloud environment elastic scalability is not only currently restricted to horizontal scaling (Scale out), but also inefficient as it tends to resource over usage due to limited scale down capabilities and full replication of instances rather than only of essential segments. Horizontal scaling is scaling through the addition of more machines or devices to the computing platform to handle the increased demand. Vertical Scaling, on the other hand, ability to scale the size of a server i.e. in this scaling the size of server is scaled either by resizing the server or by replacing that server to bigger one. Vertical scaling can handle most sudden, temporary peaks in application demand on cloud infrastructures [18].

Traditionally, most businesses have best served by using vertical scaling methods as long as possible and then scaling individual parts of application horizontally but in Cloud environment the scenario is changed and most businesses firstly served by using horizontally because the most common operating systems do not support on-the-fly (without rebooting) changes on the available CPU or memory to support this "vertical scaling" [19]. Vertical scaling typically involves making significant changes to a server's core configuration. Therefore, it's better to perform such changes manually and when try to set up scalable server arrays for (horizontal) auto scaling purposes, and then cannot change an existing server's configuration. When horizontal scaling is used together with vertical scaling, it ends up with an infrastructure that makes the most efficient use of computing resources.

IV. CONCLUSION

Cloud computing have several benefits over traditional (non- cloud) environment and have capability to handle most sudden, temporary peaks in application demand on cloud infrastructures. Virtualization technology provides good support to achieve aim of cloud computing like higher resource utilization, elasticity, reducing IT cost or capital expenditure to handle temporary loads as well as cloud computing have various flexible service and deployment models which is also one of the main issue of adopting this computing paradigm. Virtualization concepts have open shared nature which is responsible for the violation of security polices and laws as well as degrades their computing reputation and performance. So there is need to focus on privacy and on solutions of various security problems to maintain the trust level of organization for deploying the cloud computing without any hesitation and also need of technical support for elastic scalability to serve by vertical scaling approach which is currently restricted to only horizontal scaling.

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