TOWARD THE TREND OF CLOUD COMPUTING

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ABSTRACT

Cloud Computing has recently been recognized as one of the most emerging technology. A considerable amount of research has been carried out to explore different areas in Cloud Computing. Nevertheless, few areas including reliability, security and business value of Cloud Computing are yet to be explored. This paper presents a brief summary on the analysis of current gaps and new trends in cloud computing research based on extant information systems literature, industry reports, and practical experience reflections. Additionally, it highlights the significance of cloud computing and its implications for practitioner and academics. We conclude by outlining the opportunities associated with the development of Cloud Computing and noting future research directions.

Keywords: cloud computing, service utilization, cloud services

1. Introduction

There is no doubt that Cloud Computing is making a significant impact on Information Technology (IT). It is not merely a technology concept but also a new approach of implementing electronic commerce. An idea that computing is used similarly to the way of utility consumption (e.g., electricity), is to revolutionize the development and delivery of IT services [Brynjolfsson et al. 2010]. Traditionally, companies need to acquire hardware, software to automate and improve their business processes. Additionally, IT teams were required to support the information systems infrastructure. A rapid growth in technology poses huge challenges for companies to keep with the most up to date and current technology. In order to be with the pace of the market, companies continuously spend time and resources in IT to remain competitive [Fruhling & Digman 2000].

This situation has greatly been impacted and may change with the inception of Cloud Computing. It offers valuable and useful benefits for businesses of any size or type. Generally, customers are attracted towards the promises of Cloud Computing that include but not limited to enhancing IT resources with small upfront costs. It is suggested that companies all over the world might be slowly resizing their in-house IT infrastructure and have started using computation services available on the Internet to meet their organization needs [Carr 2008].

Cloud Computing is arguably one of the most important technological shifts within last decade. In recent years, computing has become an inexpensive commodity that is reachable and affordable to many business and individual customers. This appeals to many companies, whether small or large enterprises, because with less upfront cost than the traditional way, no software and hardware to buy, and very few things to manage, they could achieve increased level of robustness and get benefit of built in redundancy of Cloud Computing environment.

Extant research suggests that Cloud Computing includes three types of models [Iyer & Henderson 2010; Mell & Grance 2011]: Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS). Under SaaS, applications (e.g., productivity, accounting or human resource applications) are provided by Cloud service provider over the Internet. Any update or change in the application is solely the responsibility of the provider. Customer pays for the service based on their opted service utilization. Under PaaS, developmental tools that help to build computer applications are managed and provided by cloud service provider over the Internet. In this situation, customers access these tools through web browser and develop new applications without installing the

development tool on their local machine. In addition, customers can customize, deploy and test the newly developed applications over the Internet and without any administrative skills of computer servers. Under IaaS, customers utilize a complete set of equipments required to support their business operations. The equipments can include hardware, storage, servers, networking component, and etc. Similar to other services, customers only pay for the service based on the usage.

In recent years, four models are proposed to deploy Cloud Computing [Cervone 2010; Iyer & Henderson 2010; Mell & Grance 2011). First model is referred to as public cloud, where cloud providers create, manage and administer cloud services for general public over the Internet on a pay-as-you use basis. Amazon Elastic Compute Cloud (Amazon EC2) is an example of public cloud. Second deployment model is referred to as private cloud. In this model, the entire cloud infrastructure is developed and provided only for a single organization. For example, Microsoft offers Windows Azure platform by which customers can build private cloud based on Windows Server environment. The third type is called community cloud in which several organizations with common interests (e.g., security and policy) work together to create and to share the cloud via Internet. For example, Google's GovCloud enables the City of Los Angeles with an isolated data environment to manage and store their applications data that can also be accessed by other city agencies. The last type of model is referred to as hybrid cloud. It consists of two or more cloud infrastructure (private, public or community). In the case, companies create, manage, administer, provide, and share resources with other organizations. For example, IBM and Juniper Networks joined hands to develop Hybrid cloud to offer cloud infrastructure services to enterprise.

2. Cloud Computing Market Trends

Cloud Computing is transforming the world of electronic commerce. There are many cloud providers that promote different cloud services that can be used to host different applications. These services function in such a way as if it is presented as part of the data centers. Table 1 summarizes a list of major cloud services available in the market. The following section explains current market trends in the industry.

Table 1: Major Cloud Services Providers

	Service Type	**Providers**	**Example**
1	Software as a Service (SaaS)	Salesforce.com Google NetSuite Apple	Sale Cloud Google Docs NetSuite CRM+ iCloud
2	Platform as a Service (PaaS)	Google Microsoft Salesforce	Google Aps Azure Force.com
3	Infrastructure as a Service (IaaS)	Amazon Savvis GoGrid	Amazon Services Colocation hosting Cloud Hosting

2.1. Private Cloud

Due to skepticism in the data security of a cloud in the public, many companies are implementing private clouds at their own premises. By having a private cloud, a company can design, develop and implement a customized cloud service and have a full control over data and other security related concern. This is not possible with the public cloud model. Generally, a company offers a number of services that are utilized by cloud users.

There are many companies which have started to develop private cloud due to data security and other reasons. For example, InterContinental Hotel Group (IHG), a parent company which owns several brands including Holiday Inn and InterContinental, announced in 2010 the adoption plan of a hybrid approach to utilize in-house computing blending with services from SaaS providers (e.g., Amazon and Saleforce). With over 60 million transactions a month, IHG replies on different cloud service providers as well as a private cloud in-house to process these transactions now. One of the main motivations behind creating a private cloud for IHG was to fully control and protects proprietary information in the organization. Other companies like RehabCare, the third largest supplier of acute care rehabilitation services in the United States, is following hybrid approach to blend private and public cloud services to grow the business [Babcock 2011].

2.2. Cloud Services utilization using Smartphone

A recent industry survey suggests that the sales of worldwide smart phones will approximately reach around 500 million units in 2011, an increase of 57.7 percent from 2010 [Cozza 2011]. An exponential growth in the sales

of smart phones has surpassed the sales of personal computers [Weintraub 2011]. The increasing sales volume presents new and exciting opportunities for cloud providers. This would indicate that additional cloud services can be offered specifically for smart phones. We expect that in coming years, different types of cloud services will empower mobile computing platforms. Mobile applications on smart phones could take advantage of cloud platforms for the development, testing and storage. As popularity and growth of smart phone increases, so would be growth in the development of private or public cloud.

2.3. Open Source Cloud Computing

The nature of open source software is such that it is developed through collaborative efforts of volunteers. More recently, there has been huge push by different technology firms to create powerful cloud services based on open standards. One of the most identical examples is the creation and development of Hadoop Framework [Brodkin 2008]. The framework, administered by Apache Software foundation, provides a reliable analysis of both complex and structure data. Currently, this framework is used by large hi-tech companies such as to Yahoo and Facebook [Zawodny 2008].

Many proponents of open source software suggest that it is critical to develop open source Cloud Computing standards as they would help the public in general and open source community specifically. Many new cloud services are developed using open source standard for the benefit of the public. Some open source Cloud Computing examples are AppScale, Cloud Foundry, Eucalyptus, Nimbus, OpenNebula, and Open Stack. Moreover, IBM, one of the largest IT companies, launched IBM Cloud Academy, a forum for academician and practitioners to advance the knowledge of Cloud Computing in education [IBM 2009].

3. The Research Implications

The boundaries of Cloud Computing research has yet to be establish. It is comparatively new area that holds a huge potential and provide benefits to the individuals as well as the organizations. At the individual level, users are able to take an advantage of cloud services for their personal or work related tasks. Potentially the data stored is accessible via mobile platforms. Perhaps the greatest benefit to users lies in not having to acquire, install and maintain the technology in use

One of the advantages for the organization is their ability to test their new business plans quickly. The idea of testing a product or service before launching to the public creates a business environment that is highly competitive. Apart from that, there is a reduced upfront cost for the organization to test business ideas by using any mix of cloud service. The cost of cloud is by paying an amount as per usage. Other advantages include less or no IT management or maintenance cost and the increase of business agility.

Associated with the market trends, current research agenda in Cloud Computing revolves around the adoption, diffusion, implementation and impact of Cloud Computing on IT development practices. The related literature lies between two major categories namely organization, and technical issues. Topic that is included in the organization category concern with adoption, diffusion, service level agreement (SLAs) creation/negotiation, social issues in Cloud Computing, and, pricing models for Cloud Computing services. In the technical category, topics are concerned with the cloud service application, workflow scheduling in Cloud Computing, cloud workflow and resource management, programming models, and, security/trust issues in Cloud Computing. Table 2 shows status of current Cloud Computing research from organization as well as technical stand point.

Table 2: Current Cloud Computing Research

Topic	Current Status	Related Reference
Analytics (Business Intelligence) using Cloud	Very few	[Mircea et al. 2011]
Reliability of Cloud	Very few	[Vogels 2008]
Social Issues in Cloud Computing	Few	[Kim et al. 2008; Provos et al. 2009]
Cloud Workflow Management	Few	[Liu et al. 2010; Wu et al. 2010]
Privacy, Security and Trust issues in Cloud Computing	Abundance	[Anthens 2010; Carlin & Curran 2011; Grobauer et al. 2011; Kaufman 2009]
Service Oriented Design and Development	Abundance	[Chen & Meixell 2003; Curley 2006; Elfatatry & Layzell 2004; Huhns & Singh 2005; Hirschheim et al. 2010; Perepletchikov 2008]
Cloud Computing Adoption	Abundance	[Grossman et al. 2009; Low et al. 2011; Misra & Mondal 2010; Tuncay 2010]

Cloud Computing has been widely embraced by different companies but the research areas in Cloud Computing are still at its infancy. There are several research issues like socio-technical impact of Cloud Computing and

reliability of cloud has not been addressed much in the literature. At the mean time, new challenging issues are emerging from adopting the Cloud Computing at an individual and organization level.

Although technical issues related to design, development and implementation of Cloud Computing has been studied, there are considerably less attentions on exploring the managerial processes of Cloud Computing development in research. For example, there is a need to investigate the new system development methodologies for the service providers and the companies which choose the hybrid models in providing the services for their users.

An agenda for future research shall also include exploring the value of utilizing Cloud Computing services in contrast to using traditional model where technology is acquired and maintained and supported. An extensive review of a literature indicate that extant research has been done on identifying risks and threats [Grobauer et al. 2011] in the cloud and ignore in measuring the organizational value drawn from the benefits of the cloud. Furthermore, utilizing cloud services would mean that companies may not keep the same level of demands on the in-house IT development and service team to support their operations. In terms of reducing cost, adopting Cloud Computing makes sense but what would be the impact of this transformation on productivity is still yet explored. For example, technical problems may be fixed averagely in two hours in the past because technical team presents in-house. Now after adopting cloud services to automate the business process, what is the time to get back on normal business operations in case a complete cloud service is on halt? In recent years, there are many examples where there were huge outages of cloud services and data losses. In 2009, Salesforce.com underwent a major outage in which 900,000 subscribers were unable to access important information in time [Goodin 2009]. In the same year, an estimated 800,000 customers of Sidekick, a smart phone configured to run on major United States telecommunication network, temporary suffer a data loss [Nusca 2009]. After this incident, Telecommunication Company halts the sale of this smart phone. In another case, Rackspace, one of the largest cloud service providers, suffered a critical data centre outage that consequently costs them approximate $3.5 million dollars in total [Brodkin 2009].

In the current economy environment, it is imperative to evaluate new type of innovation in businesses such as the adoption of cloud computing and the measurement of its impact on the bottom line [Zhuang 2005]. Moreover, the companies which are early adopters of any specific technology need to carry out rigorous in-house evaluation before making a final decision. In addition to this, it is important to note that companies that are cloud providers may have hard time becoming cloud users. For example, Google and Amazon are prominent cloud services providers but their business model only makes sense when they play a role of provider and not a user. This creates many challenges like administrative control, transparency for the user of Cloud Computing services. For example, after the outage of Amazon S3 service, many users were left abandoned from the company and questioned their transparency and accountability [Modine 2008]. Further research shall focus on creating technology tools that increase transparency and accountability of cloud services for the benefit of the users.

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