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CLOUD COMPUTING: DESCRIBING THE CONCEPT, FEATURES AND CONCERNS FROM A BUSINESS PERSPECTIVE

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ABSTRACT

Cloud computing is rapidly emerging as a legitimate alternative model for sourcing and provision of a host of computing capabilities and digitized platforms for business organizations. It offers valuable and useful benefits for businesses of any size or type. Various forms of cloud computing like 'Software as a Service' (SaaS), 'Platform as a Service' (PaaS) and 'Infrastructure as a Service' (IaaS) promise huge reduction in IT costs and complexities combined with improved accessibility, flexibility and scalability. With less upfront cost than the traditional way, no software and hardware to buy, and very few things to be managed, enterprises whether small or large could achieve increased level of robustness, and latest technologies with improved availability with this new form of technology. Its uptake in enterprise environment however, is not without challenges. There are some concerns and fears associated with the adoption of cloud computing amongst organizations. The major concerns that may hamper the adoption of cloud computing by the organizations include security, privacy, reliability, loss of control and data lock-in. This paper attempts to describe the concept of cloud computing from a business perspective and highlights business benefits provided by this model along with important concerns. The paper is concluded by outlining a migration strategy to be followed by enterprises and noting future research directions.

KEYWORDS

Cloud computing, Software as a Service, Platform as a Service, Infrastructure as a Service, Information Technology.

INTRODUCTION

Enterprises decide to invest in information systems for many reasons which include pressure to cut cost, pressure to produce more without increasing costs and simply to improve quality of services or products in order to stay in business (Legris et al., 2003). Information and Communication Technologies (ICT) provide large variety of benefits to firms in the form of reduced business costs, enhanced productivity, improved business cooperation and relationships and improved quality and diffusion of knowledge (Barbra-Sanchez et al., 2007).

Traditionally companies are required to acquire necessary hardware, software to computerize and improve their business processes. Expert IT personnel are required to manage information system infrastructure. Rapid growth and advancements in IT further pose additional challenges to companies to keep up with these changes thereby compelling companies to continuously spend more time and resources in IT to remain competitive (Wang et al., 2011). According to Truong (2010) cloud computing provides businesses altogether a different model of operation in which providers are responsible for hard parts of using software such as installation, up-gradation, maintenance, backups, failover operations and security thus resulting in huge cost savings and increased reliability on the part of users. Cloud computing has the potential to transform IT industry at large, making software more attractive as a service and shaping the way IT hardware is designed and purchased (Armbrust et al., 2010). Rose (2011) points out that cloud computing is not a new invention as such and it is actually a merging of existing technologies such as networking, virtualization, service oriented architecture which are all wrapped within an internet based delivery model where customers pay only for what they use. Sultan (2011) observed that cloud computing has received much publicity and praise from all the corners of computing landscape and his study justifies this excitement and hype. He further emphasized that flexible cost structure and scalability make cloud computing an attractive option for many SMEs especially in the current global economic crisis. Marston, et al., (2011) conclude in their study that cloud computing is to stay even though the specific roadmap for it is not clear at the moment and this is because of the general-purpose nature of many computing applications thereby offering huge economy of scale if their supply is consolidated.

Organizations that are evaluating the benefits of cloud based services must also identify the associated operational and security risks in order to develop compensating controls or to define use cases that contain an acceptable level of risk (Gartner 2008). Organizations that are planning to move to cloud are required to be fully aware about the issues concerning privacy, loss of control, security of data, and availability of services. For cloud computing to be a success, providing a simplified, convenient, centralized platform that can be used as and when required irrespective of the location, calls for sufficient attention to be paid to the problems and concerns of the various stake holders associated with it (Rose, 2011).

DEFINING CLOUD COMPUTING

There are a number of definitions of cloud computing and some of these are discussed here. Table 1 shows various definitions of cloud computing taken from various sources. As mentioned by Armbrust et al. (2010) cloud computing refers to both applications delivered as services through internet and the hardware and system software in the data centers that provide those services and cloud has been referred to as the data center hardware and software. As per Wyld (2010) cloud computing encompasses a whole range of services and can be hosted in a variety of manners, depending on the nature of services involved and the data/security needs of the contacting organizations. Gartner (2009) defined cloud computing as a style of computing where massively scalable IT related capabilities are provided as a service across the internet to multiple external customers.

According to Ryan and Loeffler (2010) the basic point of cloud computing is to avoid acquiring and maintaining computer equipment and software, increase the ease of use and flexibility of the benefit offered by the technology. Cloud allows a start-up organization to access the same technology infrastructure and support as a Fortune 500 company (Goodburn and Hill, 2010). Smith (2009) believes that cloud computing is a means of renting computers, storage and network capacity on an hourly basis from some company that already has these resources in its own data centre and can make them available to a company and company's customers via the internet. Hayes (2008) points out that whether it is called cloud computing or on demand computing, software as a service, or internet as platform, the common element is a shift in the geography of computation. According to DeFelice (2010), the easiest way to think about cloud computing is as doing business on the web, therefore eliminating the need for in-house technology infrastructure-servers and software to purchase, run and maintain. Buyya et al., (2008) defined cloud computing as a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service level agreements established through negotiations between the service providers and consumers.

Definition of cloud computing by Marston et al., (2010) emphasized on aspects such as resource utilization, virtualization, architecture abstraction, dynamic resource scalability elasticity, ubiquity and operational expenses. Truong (2010) highlighted three major characteristics of cloud computing definition which are on demand provisioning of scalable resources, virtualization, and maintenance & management free. Sultan (2010), observed that there is no any common standard definition of cloud computing, however the definition that described cloud computing as a cluster of distributed computers capable of providing on demand resources and service over some kind of network, has found to be commonly accepted. Some of the definitions are summarized in Table 1.

TABLE 1: DEFINITIONS OF CLOUD COMPUTING

DEFINITION	Reference
refers to both applications delivered as services through internet and the hardware and system software in the data centers that provide those services and cloud has been referred to as the data center hardware and software	Armbrust et al. 2010
encompasses a whole range of services and can be hosted in a variety of manners, depending on the nature of services involved and the data/security needs of the contacting organizations.	Wyld, 2010
a style of computing where massively scalable IT related capabilities are provided as a service across the internet to multiple external customers.	Gartner, 2008
a pool of abstracted, highly scalable, and managed infrastructure capable of hosting end-customer applications and billed by consumption.	Forrester, 2009
a means of renting computers, storage and network capacity on an hourly basis from some company that already has these resources in its own data centre and can make them available to a company and company's customers via the internet.	Smith, 2009
a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service level agreements established through negotiations between the service providers and consumers.	Buyya et al., 2008
an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location.	Marston et al., 2010

It is clear from the above definitions that cloud computing is an on-demand delivery of IT capabilities and functionalities as service over internet to the business organizations with various benefits such as cost advantage, scalability, flexibility and improved availability.

CLOUD COMPUTING MODELS

There are three types of cloud computing service delivery models-SaaS, PaaS and IaaS. Along with these delivery models there are four deployment models which are described in the following section.

CLOUD SERVICE DELIVERY MODELS

As held by Rimal et al., (2011) based on the type of service offered; there are three service delivery models which are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

Software as a service (SaaS): It is an multi-tenant platform which uses common resources and a single instance of both the object code of an application and underlying databases which can support various customers simultaneously (Rimal et al., 2011). In this model applications are delivered as a service through internet thereby freeing the user from complex hardware and software management (Sultan, 2011).

Platform as a service (PaaS): In this model operating systems, databases, middleware, web servers and other software are provided remotely as a service by cloud providers (Sultan, 2011). The main objective is to provide developers a platform including all the systems and environment comprising the end-to-end life cycle of developing, testing, deploying and hosting of sophisticated web applications as a service delivered by a cloud based platform (Rimal et al., 2011).

Infrastructure as a Service (IaaS): Services offered in this model include remote delivery of full computer infrastructure (Sultan, 2011). The main advantage of this model is that the users are not required to invest in building and managing the IT system hardware (Rimal et al., 2011).

CLOUD SERVICE DEPLOYMENT MODELS

According to Dillon et al.,(2010) four cloud deployment models have been defined in the cloud community:

Private cloud: Cloud infrastructure is operated solely within one particular organization and managed by the organization or a third party regardless whether it is located on premise or off premise.

Community cloud: The cloud infrastructure supports a specific community and is shared by several organizations of that community (Wyld, 2010). In this model several organizations jointly construct and share the same cloud infrastructure and the same could be hosted by a **third party vendor or within one of the organization in the community (Dillon et al., 2010).**

Public cloud: Cloud infrastructure is made available to the general public or a large industry group and is own by an organization selling cloud services (Wyld, 2010).

Hybrid cloud: The cloud infrastructure is a composition of two or more clouds as mentioned above, that remain unique entities but are bound together by standardized or proprietary technology that enable data and application portability (Wyld, 2010).

CLOUD COMPUTING BENEFITS

According to Smith (2009) main business benefits of cloud computing include scalability, cost advantage and automatic updates and upgrades. The ability to plug in to IT services via the cloud opens up many, often transformational opportunities, well beyond technology efficiencies and cost savings. These include easy deployment; increased speed to market; leveraging collective mind-share and development efforts of the extended cloud computing; shifting IT spending from a capital expense to an operating expense (Goodburn and Hill 2010). Ryan and Loeffler (2010) believe that flexible pricing on a pay-for-use basis is a big piece of value proposition, along with the rapid increase and decrease of usage with minimal involvement by the service provider. According to Wyld (2010), there are eight fundamental elements that are vital in enabling the cloud computing concept which include universal connectivity, open access, reliability, interoperability, security, privacy, economic value and sustainability. According to DeFlice (2010) major benefits of cloud computing as pointed out by vendors and analysts include quick implementation process, lower up-front costs, easier and more regular updates, disaster recovery and back up capabilities etc. The key advantages identified by Marston et al., (2010) include lower cost of entry for smaller firms trying to benefit from the latest information technologies; faster time to market; lower IT barriers to innovation and scalability. Bajenaru (2010) observes that both client and provider are benefited by cloud computing where client gets on demand access to computing resources with no upfront expenses and provider gets benefited by efficient utilization of physical resources through efficient distribution. He further states that society as a whole too gets benefited by cloud computing in terms of less physical hardware equipments, better efficiencies, less power consumption leading to green computing. Major benefits of cloud computing are summarized in Table 2.

TABLE 2: CLOUD COMPUTING BENEFITS

Sr. No.	Benefit	Description
1.	Cost	Lower cost is the core benefit of Cloud Computing because in cloud computing customers pay only for what they use, customers avoid capital expenditure in IT infrastructure and they avoid costs for maintaining the IT infrastructure, the support staff to maintain the resources and the software licensing costs.
2.	Scalability	Scalability means greater flexibility; customers can easily add as much capacity as they need allowing for improved business performance.
3.	Speed to implement	In can take only a few days or in some cases hours to implement an application in a Cloud.
4.	Accessible over internet	Clouds are accessed over the Internet making business applications accessible from any location using standard clients.
5.	Diversification/Innovation	Clouds provides organizations the ability to diversify the use of IT systems, which they would otherwise not consider, this can bring about the potential for new business opportunities and new markets.
6.	Improved business continuity	Cloud Computing makes it easier for organizations to introduce business continuity and disaster recovery capabilities, by using Cloud resources for redundancy.
7.	Green IT	Cloud Computing is environmentally friendly, since organizations share computing resources, and thus should lead to the reduction of electric power consumption by virtue of some very power-hungry data centers closing down.

CLOUD COMPUTING CONCERNS

Cloud computing is an emerging computing service paradigm and like other services of this type, there are certain concerns, fears and uncertainties associated with it and major among these are control, vendor lock-in, performance, latency, security, privacy and reliability (Sultan, 2011). Dillon et al., (2010) mentioned that based on a survey conducted by IDC in 2008, the major challenges that prevent cloud computing from being adopted by the organization include security, performance, availability, hard to integrate with in-house IT, and not enough ability to customize. Armbrust et al., (2010) highlighted three critical obstacles to the growth of cloud computing which might affect its adoption which include availability/business continuity, data lock-in, data confidentiality and auditability. Privacy of business and personal information has been mentioned as one of the major downside of cloud computing by Katzan (2010) which includes a set of complex and comprehensive issues and a cautious approach is recommended to be adopted by users and providers while moving to the cloud. Thus security, privacy, loss of control and availability emerge out to be the major concerns associated with cloud computing adoption. Major concerns are highlighted in table3.

TABLE 3: CLOUD COMPUTING CONCERNS

Sr. No.	Concern	Description
1.	Security	due to the nature of Cloud Computing with its multi-tenancy and shared resources characteristics, there is risk of failure in the infrastructure potentially exposing important information.
2.	Loss of control	Cloud Computing means that an organization gives up control of aspects of their IT infrastructure which execute their business applications. This makes the organization dependent on service provider.
3.	Vendor Lock-in	Vendor lock-in refers to a situation in which a cloud customer is stuck to current cloud vendor due to the complexity in switching to another cloud vendor
4.	Interoperability	Interoperability refers to the ability to move among different cloud platforms.
5.	Compliance	For organizations that are required to provide audit compliance, Cloud Computing providers may not provide the auditing features required by law for compliance. Another concern is the inconsistency between national and international laws, making it difficult for service providers to offer compliant services.

MIGRATION STRATEGY

Cloud computing is made up of a number of new and existing technologies, combined in a way that is capable of delivering broad benefits to the enterprise. Because of its 'newness', the capabilities of cloud computing must be fully understood – especially critical aspects such as security and interoperability – before business value can be gained from their implementation.

User organizations that are evaluating when, where, how and why they should consider cloud computing services must first understand that cloud computing spans a wide range of IT enabled capabilities, from low-level infrastructure to high-level business processes. While cloud computing is delivering significant technical and business benefits to early adopters, it is still a developing market. When considering the use of cloud services or technologies, it is important to not move too quickly before first determining whether available services deliver measurable benefits for your project (IDC, 2010). As per Gartner (2008) since “cloud-computing environments are externally provided and shared, organizations need to evaluate risk in areas such as data integrity and privacy and need to understand issues in areas such as e-discovery, compliance and audit reporting”. Goodburn and Hill(2010) held that cloud implementation requires a strategic business approach so as to manage cloud implementation project properly and also to improve the risk profile of the project. They further argue that companies that are planning to move into cloud need a governance model and strategy for evaluating, selecting and deploying cloud technologies. According to Varia(2011) the cloud brings scalability, elasticity, agility and reliability to the enterprise and take full advantage of the benefits of the cloud, enterprises should adopt a phase driven migration strategy and try to take advantage as early as possible. He has suggested a six phased migration strategy to move application into the cloud comprising cloud assessment phase, proof of concept phase data migration phase, application migration phase, leverage the cloud phase and optimization phase. Infosys (2009) suggested a four phased cloud adoption strategy which need to be followed to identify the relevant business scenario for leveraging cloud consisting of assess, validate, prepare and execute. Based on various studies and literature the following adoption strategy is proposed for organizations to get maximum benefits from cloud computing and to minimize the risk associated with its implementation:-

PHASE 1: CLOUD APPRAISAL

The first thing required on the part of SMEs is to identify core and non core applications and then identify the applications which can be migrated onto the cloud. A technical assessment is required to understand which applications are more suited to the cloud architecturally and strategically. Reliable cloud vendors are to be identified and evaluated.

PHASE 2: VALIDATION

Once the right applications and right candidate identified for the cloud and efforts required to migrate estimated, it is a time to test. Pilot studies and proof of concept should be performed to identify functional gaps and to review user experience.

PHASE 3: COMPLETING THE GROUNDWORK

For migrating applications into the cloud or to use resources available on the cloud, many changes are first required to be made in the existing policies and procedures. The necessary hardware and communication infrastructure should be in place, the employees are to be trained and educated and data security, privacy, payment, availability issues to be properly clarified with the providers and are to be put into SLA.

PHASE 4: MIGRATION AND INTEGRATION

This step determines whether organizations should move only a part of an IT infrastructure to the cloud without disturbing or interrupting current business or to move the whole application at one go. After migrating the applications to the cloud, run the necessary tests and confirm that everything is working as expected. Additional benefits of the cloud should also be exploited like automatic updates and upgrades, auto recovery and auto provisioning.

PHASE 5: OPTIMIZING CLOUD

The focus in this step is on how organizations can optimize their cloud based applications in order to increase cost savings. Since payments are based on pay as you go basis, so companies should strive to optimize their systems when-ever possible. A small optimization might result in the saving of large amount in the bill.

CONCLUSION

Cloud computing is around for quite some time. It is rapidly emerging as a new and promising IT strategy having cost advantage, scalability and more flexibility and access to the most advanced & latest technologies to even small companies. As cloud computing is still evolving so there are a number of challenges and issues causing disagreement and debate in professional and academic circles. The major concerns which the companies need to consider and analyze before moving into the cloud include security, privacy, reliability, loss of control, availability, data lock in etc. So a cautious approach is recommended on the part of organizations which are planning to use cloud computing in some form. The five phased cloud adoption strategy proposed in this paper might help organization to analyze their suitability to move into the cloud and to manage cloud computing adoption project efficiently. Further research is recommended in the areas like cloud computing adoption and diffusion at organizational level, impact of cloud computing on IT development practices, pricing models and security issues involved in cloud computing.

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