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A Study to Determine How Best Cloud Computing Enables Sustainable Competitive Advantage

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Abstract: Cloud computing is an evolving paradigm. The definition characterizes important aspects of cloud computing and is intended to serve as a means for broad comparisons of cloud services and deployment strategies, and to provide a baseline for discussion from what is cloud computing to how to best use cloud computing. The service and deployment models defined form a simple taxonomy that is not intended to prescribe or constrain any particular method of deployment, service delivery, or business operation. Clearly, cloud is widely recognized as an important technology, offering capabilities that positively affect IT. However, its full business potential has yet to be realized or even understood by most organizations.

This paper aims to present the conception of cloud computing, its definitions, main service and implementation models and issues.

Keywords: Cloud, IT, Deployment Models, Business Operations, Technology.

INTRODUCTION

Cloud computing is a model for enabling ubiquitous, 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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Essential Characteristics:

1. **On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
2. **Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
3. **Resource pooling:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.
4. Rapid elasticity: Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.
5. Measured service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Service Models:

1. **Software as a Service (SaaS):** The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
2. **Platform as a Service (PaaS):** The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application - hosting environment.
3. **Infrastructure as a Service (IaaS):** The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed

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applications; and possibly limited control of select networking components (e.g., host firewalls).

Deployment Models:

1. **Private cloud:** The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.
2. **Community cloud:** The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.
3. **Public cloud**: The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.
4. **Hybrid cloud:** The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

TRADITIONAL MODEL VS CLOUD COMPUTING MODEL

In the traditional model, the enterprise, that chooses to operate on own IT infrastructure, at the beginning of its operation is forced to bear the cost of purchasing servers, network infrastructure, software etc. Provided by this equipment capacity (disk space, processing power) for a certain period of time may not be fully used (for example, the initial phase of the project starting a new business service). User will incur throughout this period the cost of the equipment maintenance (power, cooling, etc.).

In the next period further development of the company can force user's need to invest in additional infrastructure. It may occur also that the company's development will be faster than expected, and available IT resources even after increasing their potential won't be sufficient to ensure undertaking an appropriate level of IT activity. Insufficiency of IT infrastructure exposes the company to lose additional demand for products or services. The company has lower income and probably will record deterioration in financial performance. Observing the increasing demand for It resources company once again bear the necessary investment. The response of company could be little late, which may adversely affect its public image. With regard to the periodicity which occurs on market, it can be assumed that after a certain period of time the level of demand for the company's product will decrease to the level before the fast growth. The potential of the installed infrastructure will be largely untapped, while the operating costs associated with IT resources maintenance remain essentially unchanged at a relatively high level.

Business practice shows that the companies, which are capable of adapting to changing conditions in short-time, will always be in a better position than its competitors. Inability to adjust the rapid growth in demand, (skill to handle in a short time increased number of customers), usually results in their loss. Contractors move to the companies that can meet their needs, and for the enterprise is usually means deterioration of its market position. Firms basing its operations on the model of the traditional use of IT resources may find themselves in the situation described above.

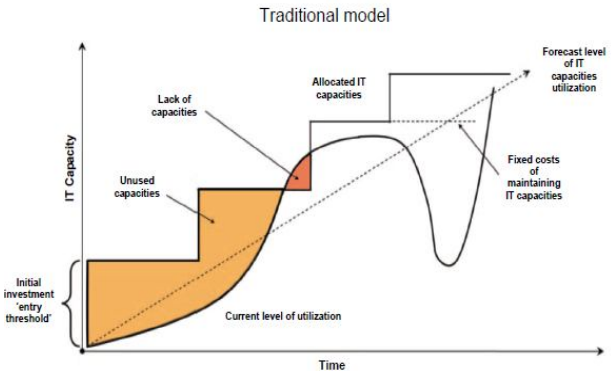

Fig 1: IT Capacity in Traditional Model

One of the solutions reducing the negative effects of described change is to asset IT management the cloud computing model. Companies which migrate their IT resources to clouds after a short time begins to achieve measurable economic benefits First of all, starting market activity, company is not forced to invest in the development of infrastructure, thereby generating savings. Borne initial costs returns very quickly, in contrast to the traditional model where the investment returns normally at a much later period. Then, with the increase of IT resources maintenance, there is no the need to invest in additional servers and software. The cloud provider offers to the recipient high scalability combined with the possibility of a flexible allocation of resources, when in fact there is a demand for it. This prevents the situation that may take place in the traditional model when own IT resources are unable to meet sudden unexpected surges of demand.

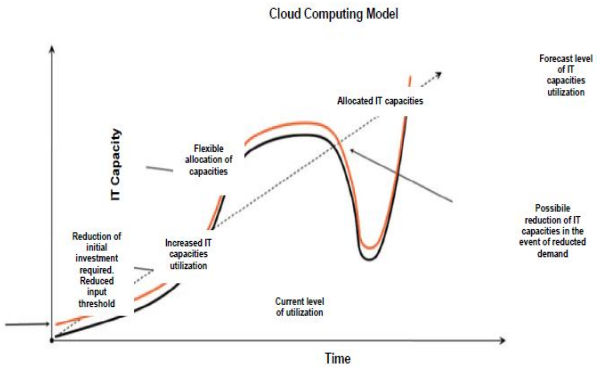

Fig 2: IT Capacity in Cloud Computing Model

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Implementation of cloud computing services reduces therefore the risk of losing additional revenues and loss of customers. Flexibility in responding for customer needs can therefore be competitive advantage.

ROLE AND IMPORTANCE OF CLOUD COMPUTING

Privacy is an important issue for cloud computing, both in terms of legal compliance and user trust, and needs to be considered at every phase of design. In this paper the privacy challenges that software engineers face when targeting the cloud as their production environment to offer services are assessed, and key design principles to address these are suggested.

Maintaining the levels of protection of data and privacy required by current legislation in cloud computing infrastructure is a new challenge, as is meeting the restrictions on cross-border data transfer. This is not just a compliance issue. As cloud services process users' data on machines that the users do not own or operate, this introduces privacy issues and can lessen users' control. Privacy issues are central to user concerns about adoption of cloud computing, and unless technological mechanisms to allay users' concerns are introduced, this may prove fatal to many different types of cloud services. For example, cloud services users report high levels of concern when presented with scenarios in which companies may put their data to uses of which they may not be aware. Users' fears of leakage of commercially sensitive data and loss of data privacy may be justified: in 2007 the cloud service provider Salesforce.com sent a letter to a million subscribers describing how customer emails and addresses had been stolen by cybercriminals. Top database vendors are adding cloud support for their databases (Oracle for example now can run directly on Amazon's cloud service platform (EC2)), and so more data is moving into the cloud. Privacy concerns will continue to grow, because these databases often contain sensitive and personal information related to companies and/or individuals. Hence, there is a key challenge for software engineers to design cloud services in such a way as to decrease privacy risk. As with security, it is necessary to design in privacy from the outset, and not just bolt on privacy mechanisms at a later stage. There is an increasing awareness for the need for design for privacy from both companies and governmental organisations. Furthermore, there are opportunities for the provision of a new range of 'privacy services' that offer a cloud computing infrastructure with assurances as to the degree of privacy offered, and related opportunities for new accountability-related services to provide certification and audit for these assurances (analogous, for example, to privacy seal provision for web services and mechanisms for privacy assurance on the service provider side).

Cost flexibility is a key reason many companies consider cloud adoption in the first place. More than 31 percent of executives surveyed cited cloud's ability to reduce fixed IT costs and shift to a more variable "pay as you go" cost structure as a top benefit.

Cloud can help an organization reduce fixed IT costs by enabling a shift from capital expenses to operational expenses. IT capital expenses – which typically include enterprise software licenses, servers and networking equipment – tend to be less fluid, more expensive and harder to forecast than routine IT operating expenses. With cloud applications, there is no longer a need to build hardware, install software or pay dedicated software license fees. By adopting cloud services, an organization can shift costs from capital to operational – or from fixed to variable. The organization pays for what it needs when it needs it. This pay-per-use model provides greater flexibility and eliminates the need for significant capital expenditures.

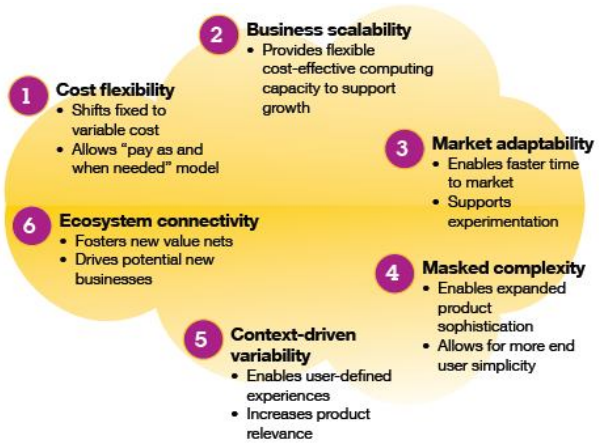

Fig 1: Cloud's Businesss enablers

Cost flexibility is certainly an appealing cloud attribute for Etsy, an online marketplace for handmade goods. In addition to bringing buyers and sellers together, Etsy also provides recommendations for buyers. Using cloud-based capabilities, the company is able to cost-effectively analyze data from the approximately one billion monthly views of its Web site and use the information to create product recommendations. The cost flexibility afforded through cloud provides Etsy access to tools and computing power that might typically only be affordable for larger retailers.

IT scalability is recognized by many as a major benefit of cloud adoption. However, cloud offers more than just IT scalability – it allows an organization to easily scale its business operations as well.

By allowing for rapid provisioning of resources without scale limitations, cloud enables a company to benefit from economies of scale without achieving large volumes on its own. Recognizing cloud's ability to facilitate efficient growth and expanded options, approximately a third in our survey view business scalability as a top cloud benefit.

For this concept in action, consider Netflix, an Internet subscription service for movies and TV shows. Because it streams many movies and shows on demand, the company faces large surges of capacity at peak times. As Netflix began to outgrow its data center capabilities, the company made a decision to migrate its Web site and streaming service from a traditional data center implementation to a cloud environment. This move allowed the company to grow and expand its customer base without having to build and support a data center footprint to meet its growth requirements.

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In today's economic environment, the ability to respond to rapidly changing customer needs is a key competitive differentiator. As such, companies continuously seek ways to improve their agility to adjust to market demands. A third of the executives we surveyed believe cloud can assist in this respect, citing market adaptability among cloud's top benefits. By enabling businesses to rapidly adjust processes, products and services to meet the changing needs of the market, cloud in turn facilitates rapid prototyping and innovation and helps speed time to market.

In addition to business scalability and market adaptability, cloud also offers the advantage of masking complexity. Cloud provides a way for organizations to "hide" some of the intricacies of their operations from end users, which can help attract a broader range of consumers. Because complexity is veiled from the end user, a company can expand its product and service sophistication without also increasing the level of user knowledge necessary to utilize or maintain the product or service. For example, upgrades and maintenance can be done in the "background" without the end user having to participate.

Masked complexity is perhaps less recognized than some of the other enablers, as 20 percent of the business leaders in our survey cited it as a top benefit. Xerox definitely recognizes this cloud attribute, however, as evidenced by its Xerox Cloud Print solution. With Xerox Cloud Print, workers can get their desired content in printed form wherever they might be by using Xerox's cloud to access printers outside their own organization.6 While printing from the cloud requires quite a bit of data management – with numerous files to be stored, converted to print-ready format and distributed to printers – the complexity is hidden from users.

Because of its expanded computing power and capacity, cloud can store information about user preferences, which can enable product or service customization. The context-driven vari- ability provided via cloud allows businesses to offer users personal experiences that adapt to subtle changes in user- defined context, allowing for a more user-centric experience. This is a significant cloud attribute, as evidenced by the more than 50 percent of respondents who cited "addressing frag- mented user preferences" as important for their organizations.

Siri, the Apple iPhone 4S cloud-based natural language "intelligent assistant," is all about context-driven variability. It allows users to send messages, schedule meetings, place phone calls, find restaurants and more.7 And while other phones have some voice recognition features, Siri "learns your voice" as Wall Street Journal columnist Walt Mossberg put it.8 Siri uses artificial intelligence and a growing base of knowledge about the user, including his or her location and frequent contacts, to understand not only what is said but what is meant. In a nutshell, it leverages the computing capabilities and capacity of cloud to enable individualized, context-relevant customer experiences.

Another business enabler powered by cloud is ecosystem connectivity, which is recognized by a third of our respondents as a major benefit. Cloud facilitates external collaboration with partners and customers, which can lead to improvements in productivity and increased innovation. Cloud-based platforms can bring together disparate groups of people who can collaborate and share resources, information and processes.

HealthHiway is a great example of how cloud can enable ecosystem connectivity. A cloud-based health information network, HealthHiway enables the exchange of information and transactions among healthcare providers, employers, payers, practitioners, third-party administrators and patients in India. By connecting more than 1,100 hospitals and 10,000 doctors, the company's software-as-a-service solution facilitates better collaboration and information sharing, helping deliver improved care at a low cost, particularly important in growing markets, such as India.

IMPLEMENTATION ISSUES

Current cloud service providers operate very large systems. They have sophisticated processes and expert personnel for maintaining their systems, which small enterprises may not have access to. As a result, there are many direct and indirect security advantages for the cloud users. Here we present some of the key security advantages of a cloud computing environment.

1. **Data Centralization**: In a cloud environment, the service provider takes care of storage issues and small business need not spend a lot of money on physical storage devices. Also, cloud based storage provides a way to centralize the data faster and potentially cheaper. This is particularly useful for small businesses, which cannot spend additional money on security professionals to monitor the data.
2. **Incident Response**: IaaS providers can put up a dedicated forensic server that can be used on demand basis. Whenever a security violation takes place, the server can be brought online. In some investigation cases, backup of the environment can be easily made and put onto the cloud without affecting the normal course of business.
3. **Forensic Image Verification Time:** Some cloud storage implementations expose a cryptographic check sum or hash. For example, Amazon S3 generates MD5 (Message-Digest algorithm) hash automatically when you store an object. Therefore in theory, the need to generate time consuming MD5 checksums using external tools is eliminated.
4. **Logging:** In a traditional computing paradigm by and large, logging is often an afterthought. In general, insufficient disk space is allocated that makes logging either non-existent or minimal. However, in a cloud, storage need for standard logs is automatically solved.

In spite of security advantages, cloud computing paradigm also introduces some key security challenges. Here we discuss some of these key security challenges.

1. **Data Location:** In general, cloud users are not aware of the exact location of the datacenter and also they do not have any control over the physical access mechanisms to that data. Most well-known cloud service providers have datacenters around the globe. Some service providers also take advantage of their global datacenters. However, in some cases applications and data might be stored in countries, which can judiciary concerns. For example, if the user data is stored in X country then service providers

will be subjected to the security requirements and legal obligations of X country. This may also happen that a user does not have the information of these issues.

2. **Investigation:** Investigating an illegitimate activity may be impossible in cloud environments. Cloud services are especially hard to investigate, because data for multiple customers may be co-located and may also be spread across multiple datacenters. Users have little knowledge about the network topology of the underlying environment. Service provider may also impose restrictions on the network security of the service users.
3. **Data Segregation**: Data in the cloud is typically in a shared environment together with data from other customers. Encryption cannot be assumed as the single solution for data segregation problems. In some situations, customers may not want to encrypt data because there may be a case when encryption accident can destroy the data.
4. **Long-term Viability:** Service providers must ensure the data safety in changing business situations such as mergers and acquisitions. Customers must ensure data availability in these situations. Service provider must also make sure data security in negative business conditions like prolonged outage etc.

5**. Compromised Servers**: In a cloud computing environment, users do not even have a choice of using physical acquisition toolkit. In situation, where a server is compromised; they need to shut their servers down until they get a previous backup of the data. This will further cause availability concerns.

6. Regulatory Compliance: Traditional service providers are subjected to external audits and security certifications. If a cloud service provider does not adhere to these security audits, then it leads to a obvious decrease in customer trust.

7. Recovery: Cloud service providers must ensure the data security in natural and man-made disasters. Generally, data is replicated across multiple sites. However, in the case of any such unwanted event, provider must do a complete and quick restoration.

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CONCLUSION

Although cloud has practically become main stream in the IT world, its promise extends well beyond technological innovation. In fact, cloud has the power to open doors to more efficient, responsive and innovative ways of doing business. Companies worldwide are beginning to recognize cloud's capabilities to generate new business models and promote sustainable competitive advantage. Organizations can pursue the business benefits of cloud by establishing shared responsibility for cloud strategy and governance looking internally and externally for ways to maximize the value of cloud adoption and determining whether to be an optimizer, innovator or disruptor.

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