Cloud Computing

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ABSTRACT

The purpose of this article is to provide information about Cloud Computing. As a subject matter that is often mentioned, but not quite understood, the authors decided to cover areas that go over the history, evolution, adoption, threats, and opportunities that exist with Cloud Computing and businesses today. Cloud Computing is the latest hype in the technology world, and organizations are taking notice. It is changing the way industries and enterprises do their business, while allowing users with less capital to utilize the same services and create a competitive advantage. It is emerging as one of the major enablers for all organizations, big or small, and causing businesses to re-evaluate their business models and IT infrastructure strategies.

Keywords: Cloud Computing; Software as a Service (SaaS); Cloud Bursting; Security Cloud Computing

INTRODUCTION

Cloud computing is an emerging technology which could replace traditional IT systems. Cloud computing makes it possible for an organization's IT to be more flexible, save costs and process information and data faster than with traditional IT. The problem, though, lies in the riskiness of this new technology. It is important to know whether value can be added for (growing or upcoming) 'ICT intensive' (meaning core business uses ICT) organizations through the use of cloud computing. The existing approaches on this problem mainly focus on one side of computing - either benefits or risks. Also, these approaches are often focused on the end user of the cloud and not the organizations using it. Different aspects, such as the (valuable) possibilities of cloud computing, are discussed as also the risks and issues that cloud computing brings. It is necessary to point out the different views and aspects of cloud computing in order to provide a meaningful conclusion at the end of this research and say something useful about the possible implementation of cloud computing in ICT intensive companies.

WHAT IS A "CLOUD?"

Many possible definitions are to be found for cloud computing. Most of them focus only on the technology (Mell, 2011 & Vaquero, 2009). Research has been done in order to combine all of these different definitions to come up with one (proposed) uniform definition by Vaquero (2009). Cloud computing can best be described as a giant pool which contains hardware, software, and other services that can be accessed through the "cloud". All these resources can be accessed whenever necessary. In most cases, the provider of the cloud sells his service as pay-per-use. This means that there is high flexibility in the use of these services as extra resources are always available (Strickland, 2011).

The definition, as described above, still leaves a lot of questions about what cloud computing actually is. The giant pool, as mentioned earlier, refers to the available hardware, software, and services as provided by cloud-providing organizations. These organizations, such as Google and Amazon, have hardware, software, and services running on their own servers at certain fixed locations.

As it becomes clear, there is no uniform definition yet for cloud computing, though they all point into the same direction. It is also made clear that there is definitely a prosperous future for cloud computing (Hayes, 2008). Hayes mentions that software is moving toward the cloud in the future, whereas it currently comes from the local PCs. It is expected that users and developers will follow this trend. People often do not know they are using cloud computing. A simple example is Gmail or Google docs (http://docs.google.com/support/) in that they are free

services and perfectly explains what cloud computing is. Google doc makes it possible for you, and other users, to work online with a word processer with multiple users logged on. The complete document and service are stored online. Any changes made to a document appear real-time to the other users. Cloud computing is relatively much cheaper than when you buy actual software licenses or hardware. Think of organizations that only temporarily need additional software or hardware (computing power); it would be a waste of investment to purchase these additionally.

Most growing, starting, or expanding (or even large) IT intensive organizations would probably save costs and gain flexibility when using cloud computing (Armbrust et al, 2009); however, it is important to research whether this statement is completely true and if the benefits exceed the risks of having cloud computing.

CLOUD OPERATING ENVIRONMENT- IN A NUTSHELL

Deployment Models

Similar to P/I/SaaS, clouds may be hosted and employed in different fashions, depending on the use case, respectively the business model of the provider. So far, there has been a tendency of clouds to evolve from private, internal solutions (private clouds) to manage the local infrastructure and the amount of requests - to ensure availability of highly requested data. This is due to the fact that data centers initiating cloud capabilities made use of these features for internal purposes before considering selling the capabilities publicly (public clouds). Only now that the providers have gained confidence in publication and exposition of cloud features do the first hybrid solutions emerge. This movement from private, via public, to combined solutions is often considered a "natural" evolution of such systems, though there is no reason for providers to not start up with hybrid solutions once the necessary technologies have reached a mature enough position. Therefore, one can distinguish between the following deployment types:

Private Clouds

These are typically owned by the respective enterprise and/or are leased. Functionalities are not directly exposed to the customer, though, in some cases, services with cloud-enhanced features may be offered, which is similar to (Cloud) Software as a service from the customer's point of view.

Example: eBay

Public Clouds

Enterprises may use cloud functionality from others, respectively, who offer their own services to users outside of the company. Providing the user with the actual capability to exploit the cloud features for his/her own purposes also allows other enterprises to outsource their services to such cloud providers, thus reducing costs and effort to build up their own infrastructure. As noted in the context of cloud types, the scope of functionalities thereby may differ.

Example: Amazon, Google Apps, Windows Azure, Dropbox

Hybrid Clouds

Though public clouds allow enterprises to outsource parts of their infrastructure to cloud providers, they, at the same time, would lose control over the resources and the distribution/management of code and data. In some cases, this is not desired by the respective enterprise. Hybrid clouds consist of a mixed employment of private and public cloud infrastructures so as to achieve a maximum of cost reduction through outsourcing while maintaining the desired degree of control over e.g. sensitive data by employing local private clouds. There are actually not many hybrid clouds in use today, though initial initiatives, such as the one by IBM and Juniper, already introduce base technologies for their realization

Community Clouds

Typically, cloud systems are restricted to the local infrastructure - providers of public clouds offer their own infrastructure to customers. Though the provider could actually resell the infrastructure of another provider, clouds do not aggregate infrastructures to build up larger, cross-boundary structures. In particular, smaller SMEs could profit from community clouds to which different entities contribute with their respective (smaller) infrastructure. Community clouds can either aggregate public clouds or dedicated resource infrastructures. We may thereby distinguish between private and public community clouds. For example, smaller organizations may come together only to pool their resources for building a private community cloud. As opposed to this, resellers, such as Zimory, may pool cloud resources from different providers and resell them.

Service Models

Cloud providers typically center on one type of cloud functionality provisioning - Infrastructure, Platform or Software/Application- though there is potentially no restriction to offer multiple types at the same time, which can often be observed in PaaS (Platform as a Service) providers that offer specific applications too, such as Google App Engine in combination with Google Docs. Due to this combinatorial capability, these types are also often referred to as "components". Literature and publications typically differ slightly in terminologies applied, which is mostly due to the fact that some application areas overlap and are therefore difficult to distinguish. As an example, platforms typically have to provide access to resources indirectly and thus are sometimes confused with infrastructures. Additionally, more popular terms have been introduced in less technologically-centered publications. The following list identifies the main types of clouds (currently in use):

Infrastructure as a Service (IaaS)

IaaS - also referred to as Resource Clouds - provide (managed and scalable) resources as services to the user; in other words, they basically provide enhanced virtualization capabilities. Accordingly, different resources may be provided via a service interface. Data & Storage Clouds deal with reliable access to data of potentially dynamic size, weighing resource usage with access requirements and/or quality definition.

Examples: Amazon S3, SQL Azure

Platform as a Service (PaaS)

PaaS provides computational resources via a platform upon which applications and services can be developed and hosted. PaaS typically makes use of dedicated APIs to control the behavior of a server-hosting engine that executes and replicates the execution according to user requests (e.g. access rate). As each provider exposes his/her own API, according to the respective key capabilities, applications developed for one specific cloud provider cannot be moved to another cloud host. There are, however, attempts to extend generic programming models with cloud capabilities such as MS Azure.

Examples: Force.com, Google App Engine, Windows Azure (Platform)

Software as a Service (SaaS)

SaaS is also sometimes referred to as Service or Application Clouds and offers implementations of specific business functions and business processes that are provided with specific cloud capabilities; i.e., they provide applications/services using a cloud infrastructure or platform rather than providing cloud features themselves. Often, this kind of standard application software functionality is offered within a cloud.

Examples: Google Docs, Salesforce CRM, SAP Business by Design

Salesforce.com - Customer Service Software as a Service

"The world is changing. Customers are demanding more and better service delivered through every conceivable channel. That's why more companies are using salesforce.com's customer service 'software as a service' solution for call center CRM and help desk management. The key contrast with traditional customer support software is "software as a service" model. Salesforce's CRM customer service and support is delivered by subscription over the Web, unlike on premise customer service software. So, there is no hardware or software to purchase or maintain and no lengthy deployment cycle to impede you, your agents, or your customers".

Amazon.com - Amazon Cloud Services-AWS

Amazon is one of the first companies to offer cloud services to the public. It offers a number of cloud services, as can see from their website mentioned below.

- **Elastic Compute Cloud (EC2)** offers virtual machines and extra CPU cycles for your organization.
- **Simple Storage Service (S3)** allows you to store items, up to 5GB in size, in Amazon's virtual storage service.
- **Simple Queue Service (SQS)** allows your machines to talk to each other using this message-passing API. SQS is a distributed queue messaging service that supports the programmatic sending of messages via web service applications as a way to communicate over the Internet. The intent of SQS is to provide a scalable hosted message queue that resolves issues arising from the common producer-consumer problem or connectivity between producers and consumers.
- **SimpleDB** is a web service for running queries on structured data in real time. This service works in close conjunction with Amazon Simple Storage Service (Amazon S3) and Amazon Elastic Compute Cloud (Amazon EC2), collectively providing the ability to store, process, and query data sets in the cloud. These services can be difficult to use because they have to be done through the command line. If you are used to working in a command-line environment, you shouldn't have much trouble using this service.
- **Cloud Front** is a content delivery network that delivers user content using a global network of edge locations. Requests for objects are automatically routed to the nearest edge location, so content is delivered with the best possible performance. Cloud Front works with S3 which durably stores the original, definitive versions of files
- You can see more about Amazon' cloud services at http://aws.amazon.com.

CLOUD COMPUTING AND VIRTUALIZATION

Cloud computing is an operations model - Not a technology

When you run an application in a public or private cloud, there is no "cloud layer" that your software must pass through in order to leverage the physical infrastructure available to it. In the vast majority of cases, there is probably some virtualization involved, but the existence of hypervisors clearly does not make your data center resources into a cloud; nor is the fact that Amazon EC2 uses Xen hypervisors the reason that they are a cloud. What makes a cloud a cloud is the fact that the physical resources involved are operated to deliver abstracted IT resources on demand, at scale, and (almost always) in a multi-tenant environment. It is how you use the technologies involved. For the most part, cloud computing uses the same management tools, operating systems, middleware, databases, server platforms, network cabling, storage arrays, and so on, that we have come to know and love over the last several decades. Specific technologies, of course, gain significant importance in a cloud computing environment, such as policy-driven automation, metering systems, and self-service provisioning portals. However, all of these technologies - with the possible exception of the self-service portal - existed before cloud computing became a much hyped paradigm. There is no doubt that cloud borrows much from long established technologies. It is also true that

cloud has borrowed from many long-standing operations models, such as mainframe service bureaus. However, the combination of on-demand, at scale, in a multi-tenant infrastructure is relatively unique for the post client-server era and is the reason why cloud computing is disruptive, rather than just another operations fad.

Virtualization is a Technology

When you run software in a virtual machine, the bits that represent the program's instructions run through a layer of software that "pretends" to be a dedicated server infrastructure - the hypervisor. The hypervisor is the heart and soul of server virtualization and is the enabler of the consolidation and agility values that virtualization brings to the data center. It is because of the hypervisor that virtualization is the true disruptive technology that enables cloud computing on a massive scale. Hypervisors allow servers to be multi-tenant without rewriting applications to be multi-tenant. Hypervisors allow operating systems and applications to install to a consistent hardware profile, even though they end up running on a variety of actual physical system implementations. Hypervisors also allow servers to be manipulated by software APIs, which greatly simplifies the act of automating IT operations.

- Virtualization is a framework or methodology of dividing the resources of a computer into multiple execution environments by applying one or more concepts or technologies, such as hardware and software partitioning, time-sharing, partial or complete machine simulation, emulation, quality of service, and many others.
- It allows abstraction and isolation of lower-level functionalities and underlying hardware. This enables portability of higher-level functions and sharing and/or aggregation of the physical resources.
- There are many virtualization products. All mainframe OS of the past were virtual, like MVS, VMS, VME, etc.
- Today's virtual environments are VMware1, Xen - an open source Linux-based product developed by XenSource2, etc.

Overall, cloud computing is not restricted to Infrastructure/Platform/Software as Service systems, even though it provides enhanced capabilities which act as (vertical) enablers to these systems. As such, I/P/SaaS can be considered specific "usage patterns" for cloud systems which relate to models already approached by Grid, Web Services, etc. Cloud systems are a promising way to implement these models and extend them further.

Opportunities

- It enables services to be used without any understanding of their infrastructure.
- Cloud computing works using economies of scale. It lowers the outlay expense for startup companies as they would no longer need to buy their own software or servers. Cost would be by on-demand pricing. Vendors and service providers claim costs by establishing an on-going revenue stream.
- Data and services are stored remotely but are accessible from 'anywhere'.

Challenges

- Use of cloud computing means dependence on others which could possibly limit flexibility and innovation. The 'others' are likely become the bigger Internet companies - like Google and IBM - who may monopolize the market. Some argue that this use of super computers is a return to the time of mainframe computing that the PC was a reaction against.
- Security could prove to be a big issue. It is still unclear how safe outsourced data is and when using these services, ownership of data is not always clear.
- There are also issues relating to policy and access. If your data is stored abroad, whose FOI policy do you adhere to? What happens if the remote server goes down? How will you then access files? There have been cases of users being locked out of accounts and losing access to data.

CONCLUSION

When the business grows, IT also needs to grow. The scalability and speed of deployment offered by cloud computing means that organizations can expand the IT provision instantly to meet increased requirements and can also scale it down again whenever it is required. Security is typically enhanced, along with resilience and flexibility. Responsiveness of cloud-based IT services means that organizations can react quickly to a changing business environment. Waste of both time and resources is reduced, allowing to effectively do more with less. This provides a leaner, more efficient IT model available on demand. Moving to a cloud computing model can help the company survive in a tough economic climate, equipping it with the latest business tools and giving access to advanced technologies at a fraction of the cost of purchasing and running the same systems in-house. The provider can deliver the types and quality of service required; and before you know it, you will be able to enjoy the advantages of cloud computing.

Yes, no matter if you refer to the way you work using the cloud or just getting more work done virtually, or offsite, Internet-based and hosted applications have become the backbone of how many businesses run today.

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