

Is cloud computing finally beginning to mature?

Dimitrios Zissis & Dimitrios Lekkas

Department of Product & Systems Design Engineering, University of the Aegean

Article Info

ABSTRACT

Article history:Received Aug 07th, 2012Accepted Sept 23th, 2012

Keyword:

Copyright © 2012 Institute of Advanced Engineering and Science.
All rights reserved.

Corresponding Author:

First Author,

Department of Product & Systems Design Engineering, University of the Aegean.

Email: dzissis@aegean.gr

The buzz term that came into popularity in the beginning of 2006 to describe an innovative IT deployment architecture, originated from the cloud metaphor that was used to represent the Internet in various network diagrams as early as the 1990s. In a short period of time after the term appeared, cloud solutions were being rapidly marketed by many IT companies and various new buzz words came into vogue such as "cloud in a can", "cloud bursting", and we suddenly had "blue clouds", "green clouds", "white label cloud services" and many others. We witnessed what is now being labeled as "cloud washing", the attempts of many vendors to strap the cloud term onto their traditional products, which became the source of huge disambiguation, conflicts and misunderstandings. Today, the term "cloud computing" is everywhere. A quick search on Google for the term "cloud computing" will return 267 million search results. Cloud computing is being marketed as the complex-free efficient method of accessing huge amounts of computing and storage as a service. Behind the curtains though, cloud computing has often been called a huge leap of faith and concerns were fuelled when reports started to surface of random failures (e.g. power outages) and shortcomings of cloud infrastructures. Small black clouds of uncertainty have appeared in the otherwise clear skies of cloud computing.

Currently, the industry and academia are attempting to take a more pragmatic approach to cloud computing, moving beyond the myths that surround this disruptive technology. The term cloud computing is purposefully intended to be broad and abstract, but in order to accurately study the field, it is critical that we adopt a traditional academic approach and attempt to define the field as closely as possible. Today, most authors would agree that Cloud Computing has resulted from the convergence of Grid Computing, Utility Computing and SaaS, which essentially represents the increasing trend towards the external deployment of IT resources, such as computational power, storage or business applications, and obtaining them as services [1]. 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 [2]. Cloud is a type of parallel and distributed system, consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resource(s), based on service-level agreements established through negotiation between the service provider and

Journal homepage: <http://iaesjournal.com/online/index.php/IJ-CLOSER>

consumers [3]. The essential difference between cloud computing and grid computing is virtualization, which is the key enabler of cloud computing. According to Merrill Lynch, “Cloud computing, unlike grid computing, leverages virtualization to maximize computing power. Virtualization, by separating the logical from the physical, resolves some of the challenges faced by grid computing”[4]. Recent advances in microprocessor technology and software have led to the increasing ability of commodity hardware to run applications within Virtual Machines (VMs) efficiently. VMs allow for both the isolation of applications from the underlying hardware and other VMs, and the customization of the platform to suit the needs of the end-user [3]. Overall, cloud computing provides for a cognitive abstraction, providing a collection of geographically dispersed and technically diverse IT resources appear as a seamless single resource.

But why is cloud computing so successful? According to the research firm Gartner, the cloud market will grow to \$102.1 billion net year, up from \$68.3 billion last year. In traditional data centers, upgrading both hardware and software was a near-constant, highly complex and error prone activity. Managing and moving data was often equally problematic. In large IT deployments, huge data sets had to be replicated between sites. Infrastructure scaling was a nightmare and it was almost impossible to shift computing power to a particular project team that required it for a brief window of time. Cloud computing is able to provide flexibility, manageability, web accessibility and hassle free cost-effectiveness. Cloud computing has even been labeled as the democratization of supercomputing [5]. Amazon recently offered a virtual supercomputer which climbed to the 42d place on the list of the fastest super-computers in the world. Amazons virtual supercomputer can run at 240 teraflops, handling 240 trillion calculations a second for the price of \$1,279 per hour. Although that does not appear cheap the alternative of building a supercomputer is priced at around 20 million dollars face price and around 10 million per year running costs.

Cloud computing is available in a number of service models:

- Infrastructure as a Service (IaaS). Provides the consumer with the capability to provision processing, storage, networks, and other fundamental computing resources, and allow the consumer to deploy and run arbitrary software, which can include operating systems and applications. The consumer has control over operating systems, storage, deployed applications, and possibly limited control of select networking components. Notable commercial solutions of IAAS are the Amazon Cloud, Rackspace Cloud and GoGrid.
- Platform as a Service (PaaS). Provides the consumer with the capability to deploy onto the cloud infrastructure, consumer-created or acquired applications, produced using programming languages 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 application hosting environment configurations. Notable commercial solutions of PaaS are Heroku, Google App Engine and Microsoft Azure.
- Software as a Service (SaaS). Provides the consumer with the capability to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices, through a thin client interface, such as a web browser (e.g. web-based email). 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. Notable commercial solutions of SaaS are Google Apps and Salesforce.com.

Four deployment models have been identified for cloud architecture solutions, described below:

- Private cloud. The cloud infrastructure is operated for a private organization. It may be managed by the organization or a third party, and may exist on premise or off premise. The availability of open source cloud infrastructure software such as Nimbus and Eucalyptus, and the open source virtualization software stacks such as Xen Hypervisor, allows organizations to build private clouds to improve the resource utilization of the available computation facilities.
- Community cloud. The cloud infrastructure is shared by several organizations and supports a specific community that has communal concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party, and may exist on premise or off premise.
- Public cloud. The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

- Hybrid cloud. The cloud infrastructure is a composition of two or more clouds (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)(2). Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and bursts into a public cloud when the demand for computing capacity spikes.

Today we are seeing individuals and organizations coming to the cloud from many different directions. Governments across the globe are deploying cloud computing frameworks to achieve cost reductions and high availability of services. We have recently witnessed even financial services moving to the cloud [6]. Banking with its high security needs and strict regulations, was always considered to be one of the last industries to enter the cloud. But is now safe to claim that cloud computing proposes a safe, trusted and hassle free option. In a phrase, “No... at least not yet”. Although cloud computing has met with a large commercial success, a number of issues create barriers of entry and remain open for improvement.

From a security perspective, a number of uncharted risks and challenges have been introduced from this relocation to the clouds, deteriorating much of the effectiveness of traditional protection mechanisms. Unique characteristics in cloud deployments such as, multitenancy and data remnance may lead to the unwilling disclosure of private data. But also issues regarding availability, reliability and quality of services may deter the effectiveness of a cloud solution. Only recently a power outage in the cloud brought a number of popular websites crashing down. Only then did the dependence of various unrelated services on the virtual infrastructure become obvious, as users were unable to access their accounts and required services for an extended period of time.

But also questions regarding data control and user authorization in the cloud, are often raised. Who actually has permission to view our data, in what form and is this permission transitive to third parties including the government. Which laws are actually applicable to data protection and liability for services in the cloud? And of course who is responsible for risk? An example of a service contract for a cloud service states that “neither we nor any of our licensors shall be liable to you for any direct, indirect, incidental, special, consequential or exemplary damages, including, but not limited to, damages for loss of profits, goodwill, use, data or other losses”. Legal and jurisdictionary issues are often raised in cloud infrastructures that cross many traditional borders. Various proposals are currently being investigated in research labs across the world to address these issues, such as building a regulatory framework for enabling privacy-enhanced infrastructure clouds (TClouds Project), performing homomorphic encryption in the cloud, achieving cloud federated identity for account safety, multi-level security isolation guarantees with hypervisors, creating covert channels in hypervisors etc.

Apart from security, a critical aspect is vendor lock-in and essentially the lack of interoperability of services. We refer to the cloud as it being a homogenous pool of resources, such as we refer to the Internet, but the truth is that it is more like a sum of discrete individual un-interoperable small clouds. The absence of Cloud Computing Standards translates into the lack of interoperability. A developer or end user, selecting a service from a specific cloud provider has to stick with the provider, as the service is customized to this deployment, creating a lock-in. Users and developers are unable to move freely between cloud services, as these are essentially closed systems. Data portability is simply not an option to most services. Currently attempts are being made to develop cloud standards by various organizations such as the Institute of Electrical and Electronics Engineers Standards Organization, The National Institute of Standards and Technology (NIST), the Cloud Security Alliance and others.

Cloud computing is a strong driver towards the supply of computing as a service, creating unique opportunities for collaboration and innovation in the field. Cloud computing has leveraged users from hardware requirements, while reducing overall client side requirements and complexity. But cloud computing is still in its infancy; there are some steep obstacles for cloud computing to overcome before this technology matures. Cloud computing is certainly not a panacea nor a solution fit for all deployments and needs. A clear understanding of the strengths but also the limitations of this deployment model are required by information system designers and architects prior to selecting a cloud deployment. Only time will tell if cloud computing will be able to meet with these high expectations and become the default deployment architecture of the future.

REFERENCES

1. Stanoevska-Slabeva K, Wozniak T, Ristol S. Grid and Cloud Computing: A Business Perspective on Technology and Applications. Springer. 2009.
2. Mell P, Grance T. NIST SP 800-145. The NIST Definition of Cloud Computing (Draft). Recommendations of the National Institute of Standards and Technology. 2011.
3. Buyya R, Yeo CS, Venugopal S, Broberg J, Brandic I. Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. *Future Generation Computer Systems* [Internet]. 2009 Jun [cited 2012 Jul 13];25(6):599–616. Available from: <http://dx.doi.org/10.1016/j.future.2008.12.001>
4. Merrill Lynch. The Cloud Wars: \$100+ billion at stake. 2008.
5. Zax D. Amazon Democratizes Supercomputing. MIT technology review [Internet]. 2011; Available from: <http://www.technologyreview.com/view/426513/amazon-democratizes-supercomputing/>
6. Weber T. Google persuades Spanish bank BBVA to use the cloud [Internet]. BBC News. 2012; Available from: <http://www.bbc.co.uk/news/business-16486796>