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Cloud Computing

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ABSTRACT

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (**IaaS**), Platform-as-a-Service (**PaaS**) and Software-as-a-Service (**SaaS**).

Cloud is a metaphor for the internet, based on how it is depicted in computer network, diagrams etc, and is an abstraction for complex infrastructure it conceals.

A cloud service has three distinct characteristics that differentiate it from traditional hosting. It is sold on demand, typically by the minute or the hour; it is elastic -- a user can have as much or as little of a service as they want at any given time; and the service is fully managed by the provider (the consumer needs nothing but a personal computer and Internet access).

The concept behind Cloud computing is simple – "Why to buy, when you can rent it." Cloud computing enables providing services on virtual machines allocated on lap of large physical machines.

A cloud can be private or public. A **public cloud** sells services to anyone on the Internet. Currently, Amazon Web Services is the largest public cloud provider. A **private cloud** is a proprietary network or a data center that supplies hosted services to a limited number of people. When a service provider uses public cloud resources to create their private cloud, the result is called a **virtual private cloud**. Building and managing a private cloud enables you to pool hardware, storage, network, Web, and virtualization resources for more flexible, dynamic and on-demand requirements.

Significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet and a weak economy, have accelerated interest in cloud computing. It is a method to address scalability for large scale applications. It supports rapid development and eliminates management headaches.

Infrastructure-as-a-Service (IaaS) like Amazon Web Services provides virtual server to start, stop, access and configure their virtual servers and storage.

Platform-as-a-service (PaaS) in the cloud is defined as a set of software and product development tools hosted on the provider's infrastructure. Developers create applications on the provider's platform over the Internet.

In the **software-as-a-service** (SaaS) cloud model, the vendor supplies the hardware infrastructure, the software product and interacts with the user through a front-end portal.

The goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

1. Introduction

The term "cloud" is used as a **metaphor** for the Internet, based on the cloud drawing used in the past to represent the telephone network, and later to depict the Internet in **computer network diagrams** as an **abstraction** of the underlying infrastructure it represents. **Cloud computing** refers to the provision of computational resources on demand via a network. Cloud computing can be compared to the supply of electricity and gas, or the provision of telephone, television and postal services. All of these services are presented to the users in a simple way that is easy to understand without the users needing to know how the services are provided. This simplified view is called an abstraction. Similarly, cloud computing offers computer application developers and users an abstract view of services that simplifies and ignores much of the details and inner workings. A provider's offering of abstracted Internet services is often called **The Cloud**.

Cloud computing is a natural evolution of the widespread adoption of virtualization, service-oriented architecture, autonomic and utility computing. Details are abstracted from end-users, who no longer have need for expertise in, or control over, the technology infrastructure "in the cloud" that supports them.

History

The underlying concept of cloud computing dates back to the 1960s, when John McCarthy opined that "computation may someday be organized as a public utility." Almost all the modern-day characteristics of cloud computing (elastic provision, provided as a utility, online, illusion of infinite supply), the comparison to the electricity industry and the use of public, private, government and community forms was thoroughly explored in Douglas Parkhill's 1966 book, *The Challenge of the Computer Utility*.

The actual term "cloud" borrows from telephony in that telecommunications companies, who until the 1990s primarily offered dedicated point-to-point data circuits, began offering Virtual Private Network (VPN) services with comparable quality of service but at a much lower cost. By switching traffic to balance utilization as they saw fit, they were able to utilize their overall network bandwidth more effectively. The cloud symbol was used to denote the demarcation point between that which was the responsibility of the provider from that of the user. Cloud computing extends this boundary to cover servers as well as the network infrastructure. The first scholarly use of the term "cloud computing" was in a 1997 lecture by Ramnath Chellappa.

Amazon played a key role in the development of cloud computing by modernizing their data centers after the dot-com bubble, which, like most computer networks, were using as little as 10% of their capacity at any one

time, just to leave room for occasional spikes. Having found that the new cloud architecture resulted in significant internal efficiency improvements whereby small, fast-moving "two-pizza teams" could add new features faster and more easily, Amazon initiated a new product development effort to provide cloud computing to external customers, and launched Amazon Web Service (AWS) on a utility computing basis in 2006.

In 2007, Google, IBM and a number of universities embarked on a large scale cloud computing research project. In early 2008, Eucalyptus became the first open source AWS API compatible platform for deploying private clouds. In early 2008, OpenNebula, enhanced in the RESERVOIR European Commission funded project, became the first open source software for deploying private and hybrid clouds and for the federation of clouds. In the same year, efforts were focused on providing QoS guarantees (as required by real-time interactive applications) to Cloud-based infrastructures, in the framework of the IRMOS European Commission funded project. By mid-2008, Gartner saw an opportunity for cloud computing "to shape the relationship among consumers of IT services, those who use IT services and those who sell them" and observed that "Organisations are switching from company-owned hardware and software assets to per-use service-based models" so that the "projected shift to cloud computing ... will result in dramatic growth in IT products in some areas and significant reductions in other areas."

Key Characteristics

Agility improves with users' ability to rapidly and inexpensively re-provision technological infrastructure resources.

Application Programming Interface (API) accessibility to software that enables machines to interact with cloud software in the same way the user interface facilitates interaction between humans and computers. Cloud Computing systems typically use REST-based APIs.

Cost is claimed to be greatly reduced and in a public cloud delivery model capital expenditure is converted to operational expenditure. This ostensibly lowers barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and fewer IT skills are required for implementation (in-house).

Device and location independence enable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-

party) and accessed via the Internet, users can connect from anywhere.

Multi-tenancy enables sharing of resources and costs across a large pool of users thus allowing for:

Centralization of infrastructure in locations with lower costs (such as real estate, electricity, etc.)

Peak-load capacity increases (users need not engineer for highest possible load-levels)

Utilization and efficiency improvements for systems that are often only 10–20% utilized.

Reliability is improved if multiple redundant sites are used, which makes well designed

Cloud computing suitable for business continuity and disaster recovery. Nonetheless, many major cloud computing services have suffered outages, and IT and business managers can at times do little when they are affected.

Scalability via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time, without users having to engineer for peak loads. Performance is monitored, and consistent and loosely coupled architectures are constructed using web services as the system interface.

Security could improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. Security is often as good as or better than under traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford. Providers typically log accesses, but accessing the audit logs themselves can be difficult or impossible. Furthermore, the complexity of security is greatly increased when data is distributed over a wider area and / or number of devices.

Maintenance of cloud computing applications is easier, since they don't have to be installed on each user's computer. They are easier to support and to improve since the changes reach the clients instantly.

Metering means that cloud computing resources usage should be measurable and should be metered per client and application on a daily, weekly, monthly, and yearly basis.

Layers

Client

A *cloud client* consists of computer hardware and/or computer software that relies on cloud computing for application delivery, or that is specifically designed for delivery of cloud services and that, in either case, is essentially useless without it. Examples include some computers, phones and other devices, operating systems and browsers.

Application

Cloud application services or "*Software as a Service (SaaS)*" deliver software as a service over the Internet, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support. People tend to use the terms 'SaaS' and 'cloud' interchangeably, when in fact they are two different things: Key characteristics include: Network-based access to, and management of, commercially available (i.e., not custom) software

Activities that are managed from central locations rather than at each customer's site, enabling customers to access applications remotely via the Web

Application delivery that typically is closer to a one-to-many model (single instance, multi-tenant architecture) than to a one-to-one model, including architecture, pricing, partnering, and management characteristics

Centralized feature updating, which obviates the need for downloadable patches and upgrades.

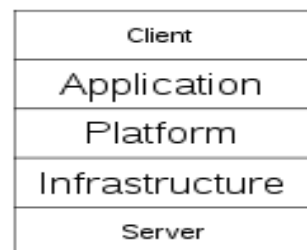
Platform

Cloud platform services or "*Platform as a Service (PaaS)*" deliver a computing platform and/or solution stack as a service, often consuming *cloud infrastructure* and sustaining *cloud applications*. It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.

Infrastructure

Cloud infrastructure services, also known as "*Infrastructure as a Service (IaaS)*", delivers computer infrastructure - typically a platform virtualization environment - as a service. Rather than purchasing servers, software, data-center space or network equipment, clients instead buy those resources as a fully outsourced service. Suppliers typically bill such services on a utility computing basis and amount of resources consumed (and therefore the cost) will typically reflect the level of activity. IaaS evolved from virtual private server offerings.

Cloud infrastructure often takes the form of a tier 3 data center with many tier 4 attributes, assembled from hundreds of virtual machine.



Server

The *servers* layer consists of computer hardware and/or computer software products that are specifically designed for the delivery of cloud services, including multi-core processors, cloud-specific operating systems and combined offerings.

Working

When a user accesses the cloud for a popular website, many things can happen. The user's IP for example can be used to establish where the user is located (geolocation). DNS services can then direct the user to a cluster of servers that are close to the user so the site can be accessed rapidly and in their local language. The user doesn't login to a server, but they login to the service they are using by obtaining a session id and/or a cookie which is stored in their browser.

What the user sees in the browser will usually come from a cluster of web servers. The web servers run software which presents the user with an interface which is used to collect commands or instructions from the user (the clicks, typing, upload etc.) These commands are then interpreted by web servers or processed by application servers. Information is then stored on or retrieved from the database servers or file servers and the user is then presented with an updated page. The data across the multiple servers is synchronised around the world for rapid global access and also to prevent data loss.

Architecture

Cloud architecture, the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over application programming interfaces, usually web services and 3-tier architecture. This resembles the Unix philosophy of having multiple programs each doing one thing well and working together over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts.

The two most significant components of cloud computing architecture are known as the front end and the back end. The front end is the part seen by the client, i.e. the computer user. This includes the client's network (or computer) and the applications used to access the cloud via a user interface such as a web browser. The back end of the cloud computing architecture is the 'cloud' itself, comprising various computers, servers and data storage devices.

Types of Cloud Computing Services**Public cloud**

Public cloud or *external cloud* describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet, via web applications/web services,

from an off-site third-party provider who bills on a fine-grained utility computing basis.

Community cloud

A *community cloud* may be established where several organizations have similar requirements and seek to share infrastructure so as to realize some of the benefits of cloud computing. With the costs spread over fewer users than a *public cloud* (but more than a single tenant) this option is more expensive but may offer a higher level of privacy, security and/or policy compliance. Examples of *community cloud* include Google's "Gov Cloud".

Hybrid cloud and hybrid IT delivery

The main responsibility of the IT department is to deliver services to the business. With the proliferation of cloud computing (both private and public) and the fact that IT departments must also deliver services via traditional, in-house methods, the newest catch-phrase has become "hybrid cloud computing." Hybrid cloud is also called hybrid delivery by the major vendors including HP, IBM, Oracle and VMware who offer technology to manage the complexity in managing the performance, security and privacy concerns that results from the mixed delivery methods of IT services.

A hybrid storage cloud uses a combination of public and private storage clouds. Hybrid storage clouds are often useful for archiving and backup functions, allowing local data to be replicated to a public cloud.

Another perspective on deploying a web application in the cloud is using Hybrid Web Hosting, where the hosting infrastructure is a mix between cloud hosting and managed dedicated servers - this is most commonly achieved as part of a web cluster in which some of the nodes are running on real physical hardware and some are running on cloud server instances.

Private cloud

Douglas Parkhill first described the concept of a "private computer utility" in his 1966 book *The Challenge of the Computer Utility*. The idea was based upon direct comparison with other industries (e.g. the electricity industry) and the extensive use of hybrid supply models to balance and mitigate risks.

Private cloud and *internal cloud* have been described as neologisms, however the concepts themselves pre-date the term *cloud* by 40 years. Even within modern utility industries, hybrid models still exist despite the formation of reasonably well-functioning markets and the ability to combine multiple providers.

Some vendors have used the terms to describe offerings that emulate cloud computing on private networks. These (typically virtualization automation) products offer the ability to host applications or virtual machines in a company's own set of hosts. These provide the benefits of utility computing -shared hardware costs, the ability to

recover from failure, and the ability to scale up or down depending upon demand.

Private clouds have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from lower up-front capital costs and less hands-on management, essentially "[lacking] the economic model that makes cloud computing such an intriguing concept". Enterprise IT organizations use their own private cloud(s) for mission critical and other operational systems to protect critical infrastructure.

Issues

Privacy

The cloud model has been criticized by privacy advocates for the greater ease in which the companies hosting the cloud services control, and thus, can monitor at will, lawfully or unlawfully, the communication and data stored between the user and the host company. Instances such as the secret NSA program, working with AT&T, and Verizon, which recorded over 10 million phone calls between American citizens, causes uncertainty among privacy advocates, and the greater powers it gives to telecommunication companies to monitor user activity. While there have been efforts (such as US-EU Safe Harbor) to "harmonize" the legal environment, providers such as Amazon still cater to major markets (typically the United States and the European Union) by deploying local infrastructure and allowing customers to select "availability zones."

Compliance

In order to obtain compliance with regulations including FISMA, HIPAA and SOX in the United States, the Data Protection Directive in the EU and the credit card industry's PCI DSS, users may have to adopt *community* or *hybrid* deployment modes which are typically more expensive and may offer restricted benefits. This is how Google is able to "manage and meet additional government policy requirements beyond FISMA" and Rackspace Cloud are able to claim PCI compliance. Customers in the EU contracting with cloud providers established outside the EU/EEA have to adhere to the EU regulations on export of personal data.

Many providers also obtain SAS 70 Type II certification (e.g. Amazon, Salesforce.com, Google and Microsoft¹), but this has been criticised on the grounds that the hand-picked set of goals and standards determined by the auditor and the auditee are often not disclosed and can vary widely. Providers typically make this information available on request, under non-disclosure agreement.

Legal

In March 2007, Dell applied to trademark the term "cloud computing" (U.S. Trademark 77,139,082) in the United States. The "Notice of Allowance" the company received in July 2008 was canceled in August, resulting in a formal

rejection of the trademark application less than a week later. Since 2007, the number of trademark filings covering cloud computing brands, goods and services has increased at an almost exponential rate. As companies sought to better position themselves for cloud computing branding and marketing efforts, cloud computing trademark filings increased by 483% between 2008 and 2009. In 2009, 116 cloud computing trademarks were filed, and trademark analysts predict that over 500 such marks could be filed during 2010.¹

Other legal cases may shape the use of cloud computing by the public sector. On October 29, 2010, Google filed a lawsuit against the U.S. Department of Interior, which opened up a bid for software that required that bidders use Microsoft's Business Productivity Online Suite. Google sued, calling the requirement "unduly restrictive of competition." Scholars have pointed out that, beginning in 2005, the prevalence of open standards and open source may have an impact on the way that public entities choose to select vendors.

Open source

Open source software has provided the foundation for many cloud computing implementations. In November 2007, the Free Software Foundation released the Affero General Public License, a version of GPLv3 intended to close a perceived legal loophole associated with free software designed to be run over a network.

Open standards

Most cloud providers expose APIs which are typically well-documented (often under a Creative Commons license but also unique to their implementation and thus not interoperable. Some vendors have adopted others' APIs and there are a number of open standards under development, including the OGF's Open Cloud Computing Interface. The Open Cloud Consortium (OCC) is working to develop consensus on early cloud computing standards and practices.

Security

The relative security of cloud computing services is a contentious issue which may be delaying its adoption. Issues barring the adoption of cloud computing are due in large part to the private and public sectors unease surrounding the external management of security based services. It is the very nature of cloud computing based services, private or public, that promote external management of provided services. This delivers great incentive amongst cloud computing service providers in producing a priority in building and maintaining strong management of secure services.

Organizations have been formed in order to provide standards for a better future in cloud computing services. One organization in particular, the Cloud Security Alliance is a non-profit organization formed to promote the use of

best practices for providing security assurance within cloud computing.

Availability and performance

In addition to concerns about security, businesses are also worried about acceptable levels of availability and performance of applications hosted in the cloud.

There are also concerns about a cloud provider shutting down for financial or legal reasons, which has happened in a number of cases.

Sustainability and siting

Although cloud computing is often assumed to be a form of "green computing", there is as of yet no published study to substantiate this assumption.^[88] Siting the servers affects the environmental effects of cloud computing. In areas where climate favors natural cooling and renewable electricity is readily available, the environmental effects

will be more moderate. Thus countries with favorable conditions, such as Finland.

Conclusion :

Cloud Computing seems to be a very promising technique of computing world that will change the IT world. There are many striking attractive features of cloud computing. It will bloom in upcoming years, making 'computation a public utility' a reality. New ideas are being introduced by researchers throughout the world. with many big names like Microsoft, IBM, HP, Cisco investing millions of dollars .

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