

# Cloud Computing

## I. What is cloud computing

**Cloud computing** is an information technology (IT) paradigm that enables ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility<sup>[1]</sup>. In the definition of National Institute of Standard and Technology (NIST), cloud computing is 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.

Rather than a new technology, cloud computing is a new operation model that brings together a set of existing technologies to run business in different way, it leverages these existing technologies to meet the technical and economic requirements of today's demand for information technology.

The figure below presents a metaphor of cloud computing

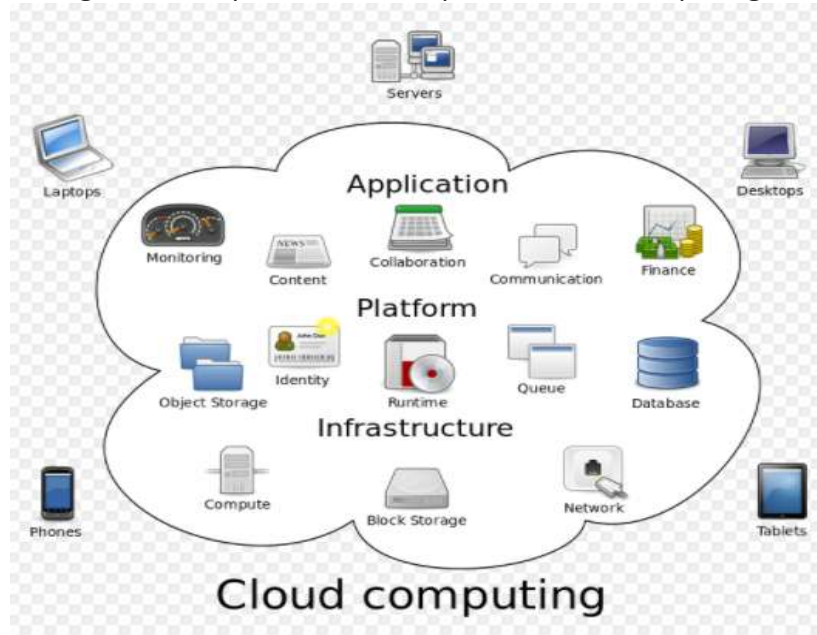


Figure 1: Cloud computing metaphor: the group of networked elements providing services need not be individually addressed or managed by users; instead, the entire provider-managed suite of hardware and software can be thought of as an amorphous cloud.

## II. Development history of cloud computing

Since 2000, cloud computing has come into existence.

1) In August 2006, Amazon introduced its Elastic Compute Cloud.

2) In April 2008, Google released Google App Engine in beta<sup>[2]</sup>.

3) In early 2008, NASA's Open Nebula, 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<sup>[3]</sup>.

3) 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"<sup>[4]</sup>.

4) In February 2010, Microsoft released Microsoft Azure, which was announced in October 2008.<sup>[5]</sup>

5) In July 2010, Rackspace Hosting and NASA jointly launched an open-source cloud-software initiative known as OpenStack. The OpenStack project intended to help organizations offering cloud-computing services running on standard hardware.

6) On March 1, 2011, IBM announced the IBM SmartCloud framework to support Smarter Planet.<sup>[29]</sup> Among the various components of the Smarter Computing foundation, cloud computing is a critical part.

7) On June 7, 2012, Oracle announced the Oracle Cloud.<sup>[30]</sup> This cloud offering is poised to be the first to provide users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers.<sup>[31][32][33]</sup>

8) In May 2012, Google Compute Engine was released in preview, before being rolled out into General Availability in December 2013.<sup>[34]</sup>

### III. Architecture of Cloud Computing

Generally speaking, Cloud architecture includes four layers<sup>[8]</sup>:

- 1) The hardware Layer: this layer is responsible for managing the physical resources of the cloud, including servers, routers, switches, power and cooling systems. It is typically implemented in data centers.
- 2) The infrastructure layer: also known as virtualization layer. It creates a pool of storage and computing resources by partitioning the physical resources using virtualization technologies such as VM ware and KVM. The infrastructure layer is an essential component of cloud computing.
- 3) The platform layer: building on the top of the infrastructure layer, the platform layer consists of operating system and application frameworks. This layer aims to minimize the burden of deploying applications directly into VM containers. Google App Engine, for example, operates at the platform layer to provide API support for implementing storage, database and business logic of typical web applications.
- 4) The application layer: At the highest level of the hierarchy, the application layer consists of the actual cloud applications. Different from traditional applications, cloud applications can leverage the automatic scaling feature to achieve better performance, availability and lower operating cost

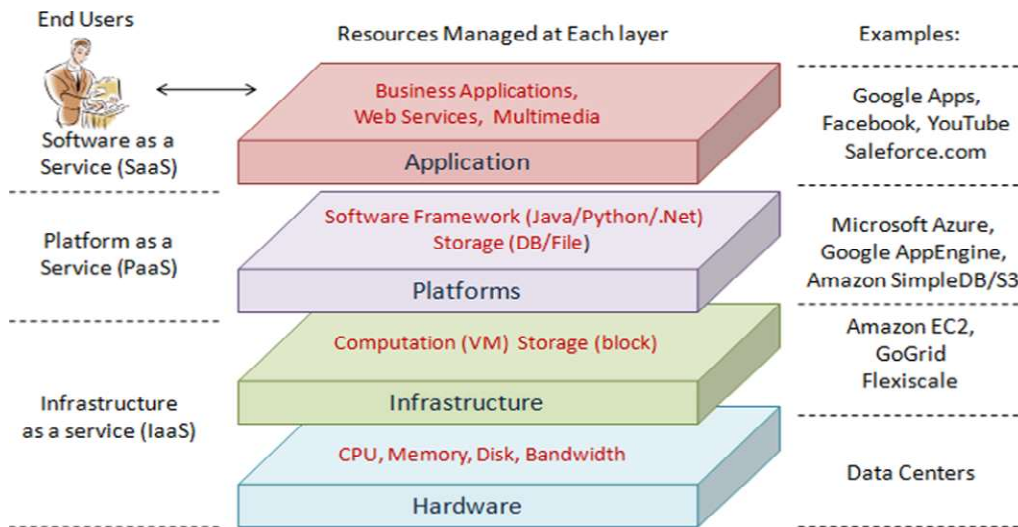


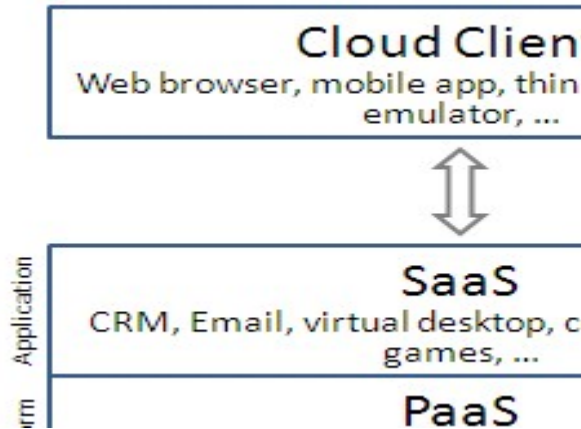
Figure 2: Cloud computing architecture

#### IV. Service Models

Cloud computing employs a service driven business model, namely hardware and platform level resources are provided as services on an on demand basis. Conceptually each layer of the architecture described in the previous section can be implemented as a service to the layer above. Conversely, every layer can be perceived as a customer of the layer below. cloud-computing providers offer their "services" according to three different standard models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

- 1) Infrastructure as a Service (IaaS): it refers to online services that provide infrastructural resources, usually in terms of VMs. The cloud owner who offers IaaS is known as IaaS provider. Example of IaaS include Amazon EC2.
- 2) Platform as a Service (PaaS): refers to providing platform layer resources, including operating system support and software development frameworks. Examples of PaaS provider include Google App Engine, Microsoft Windows Azure
- 3) Software as a Service (SaaS): it refers to providing on demand 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, or a program interface. Salesforce.com, SAP business ByDesign is example of SaaS providers.

The figure 3 depicts the business models of cloud computing arranged as layers in a stack. Since the PaaS and IaaS are often parts of same organization, such as Google and Salsforce, PaaS and IaaS providers are often called the infrastructure providers or cloud providers.



Figur 3 Cloud computing service models arranged as layers in a stack

## V. Advantages and Disadvantages of Cloud Computing<sup>[7]</sup>

There is no doubt that businesses can benefit huge from cloud computing. However, along with the many advantages, come some drawbacks as well. Understanding those advantages and disadvantages of cloud computing, you can get the most out of your business technology, whichever cloud provider you choose.

### 1. Advantages of Cloud Computing

#### 1) Cost Savings

Perhaps, the most significant cloud computing benefit is in terms of IT cost savings. Businesses, no matter what their type or size, exist to earn money while keeping capital and operational expenses to a minimum. With cloud computing, you can save substantial capital costs with zero in-house server storage and application requirements. The lack of on-premises infrastructure also removes their associated operational costs in the form of power, air conditioning and administration costs. You pay for what is used and disengage whenever you like - there is no invested IT capital to worry about. It's a common misconception that only large businesses can afford to use the cloud, when in fact, cloud services are extremely affordable for smaller businesses.

#### 2) Reliability

With a managed service platform, cloud computing is much more reliable and consistent than in-house IT infrastructure. Most providers offer a Service Level Agreement which guarantees 24/7/365 and 99.99% availability. Your organization can benefit from a massive pool of redundant IT resources, as well as quick failover mechanism - if a server fails, hosted applications and services can easily be transited to any of the available servers.

#### 3) Manageability

Cloud computing provides enhanced and simplified IT management and maintenance capabilities through central administration of resources, vendor managed infrastructure and SLA backed agreements. IT infrastructure updates and maintenance are eliminated,

as all resources are maintained by the service provider. You enjoy a simple web-based user interface for accessing software, applications and services – without the need for installation - and an SLA ensures the timely and guaranteed delivery, management and maintenance of your IT services.

#### 4) Strategic Edge

Ever-increasing computing resources give you a competitive edge over competitors, as the time you require for IT procurement is virtually nil. Your company can deploy mission critical applications that deliver significant business benefits, without any upfront costs and minimal provisioning time. Cloud computing allows you to forget about technology and focus on your key business activities and objectives. It can also help you to reduce the time needed to market newer applications and services.

## 2. Disadvantages of Cloud Computing

### 1) Downtime

As cloud service providers take care of a number of clients each day, they can become overwhelmed and may even come up against technical outages. This can lead to your business processes being temporarily suspended. Additionally, if your internet connection is offline, you will not be able to access any of your applications, server or data from the cloud.

### 2) Security

Although cloud service providers implement the best security standards and industry certifications, storing data and important files on external service providers always opens up risks. Using cloud-powered technologies means you need to provide your service provider with access to important business data. Meanwhile, being a public service opens up cloud service providers to security challenges on a routine basis. The ease in procuring and accessing cloud services can also give nefarious users the ability to scan, identify and exploit loopholes and vulnerabilities within a system. For instance, in a multi-tenant cloud architecture where multiple users are hosted on the same server, a hacker might try to break into the data of other users hosted and stored on the same server. However, such exploits and loopholes are not likely to surface, and the likelihood of a compromise is not great.

### 3) Vendor Lock-In

Although cloud service providers promise that the cloud will be flexible to use and integrate, switching cloud services is something that hasn't yet completely evolved. Organizations may find it difficult to migrate their services from one vendor to another. Hosting and integrating current cloud applications on another platform may throw up interoperability and support issues. For instance, applications developed on Microsoft Development Framework (.Net) might not work properly on the Linux platform.

#### 4) Limited Control

Since the cloud infrastructure is entirely owned, managed and monitored by the service provider, it transfers minimal control over to the customer. The customer can only control and manage the applications, data and services operated on top of that, not the backend infrastructure itself. Key administrative tasks such as server shell access, updating and firmware management may not be passed to the customer or end user.

It is easy to understand that the advantages of cloud computing outweigh the drawbacks.

## VI. Conclusion

In this paper, the definition of cloud computing is first introduced, then the development history is briefly described with some example of products. In the third and forth section, the architecture and service models of cloud computing are clearly demonstrated with figures. Then the pros and cons of the cloud computing are discussed in detail. As a newly emerged technologies, cloud computing considerably benefits businesses and gain it popularity quickly, besides its apparent superiorities, there are also some drawbacks that need to be addressed along with development of cloud computing.

## VII. References

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