Cloud Computing

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Vision of cloud computing

- One of the most diffuse views of cloud computing

  "I don't care where my servers are, who manages them, where my documents are stored, or where my applications are hosted. I just want them always available and access them from any device connected through Internet. And I am willing to pay for this service for as a long as I need it."

- Cloud computing allows anyone with a credit card to provision virtual hardware, runtime environments, and services

- The long-term vision of cloud computing is that IT services are traded as utilities in an open market, without technological and legal barriers

- The need for ubiquitous storage and compute power on demand is the most common reason to consider cloud computing

Vision of cloud computing

Cloud Computing Definition

- Given by Armbrust et al.:

  "Cloud computing refers to both the applications delivered as services over the Internet and the hardware and system software in the datacenters that provide those services"

- Proposed by the U.S. National Institute of Standards and Technology (NIST):

  "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"

- Expressed by Buyya et al.:

  "A cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers"
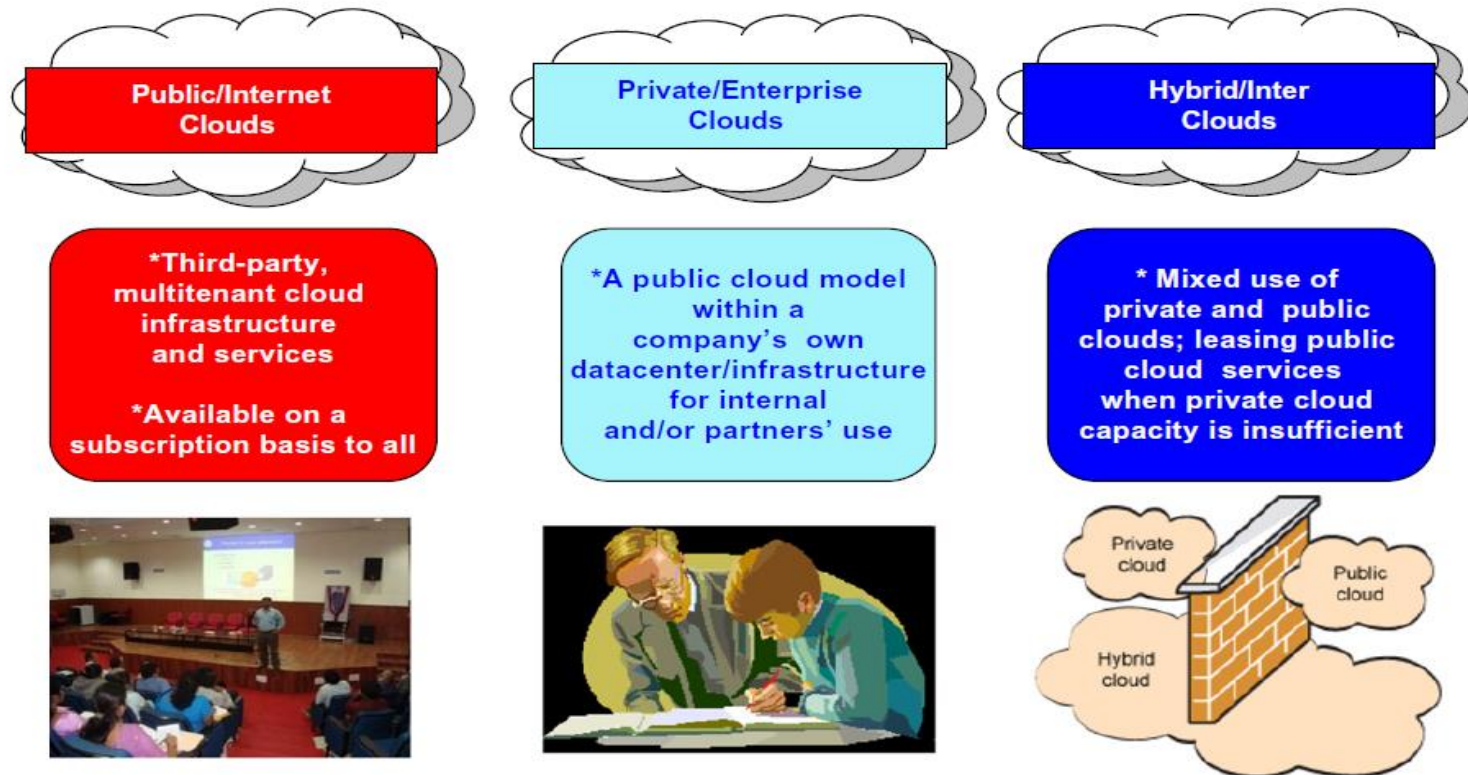
Benefits of Cloud Computing

- Large enterprises can offload some of their activities to cloud-based systems
- Small enterprises and start-ups can afford to translate their ideas into business results more quickly, without excessive up-front costs
- System developers can concentrate on the business logic rather than dealing with the complexity of infrastructure management and scalability
- End users can have their documents accessible from everywhere and any device

Major Development Models for Cloud Computing

Cloud Deployment Models

Public/Internet Clouds

Private/Enterprise Clouds

Hybrid/Inter Clouds

*Third-party, multitenant cloud infrastructure and services

*Available on a subscription basis to all

*A public cloud model within a company's own datacenter/infrastructure for internal and/or partners' use

* Mixed use of private and public clouds; leasing public cloud services when private cloud capacity is insufficient

Private cloud

Public cloud

Hybrid cloud

Cloud Computing Reference Model

- A fundamental characteristic of cloud computing is the capability to deliver, on demand, a variety of IT services that are quite diverse from each other
- Cloud computing services can be classified into three major categories:
    - *Infrastructure-as-a-Service (IaaS)*
    - *Platform-as-a-Service (PaaS)*
    - *Software-as-a-Service (SaaS)*
- The model organizes the wide range of cloud computing services into a layered view that walks the computing stack from bottom to top.
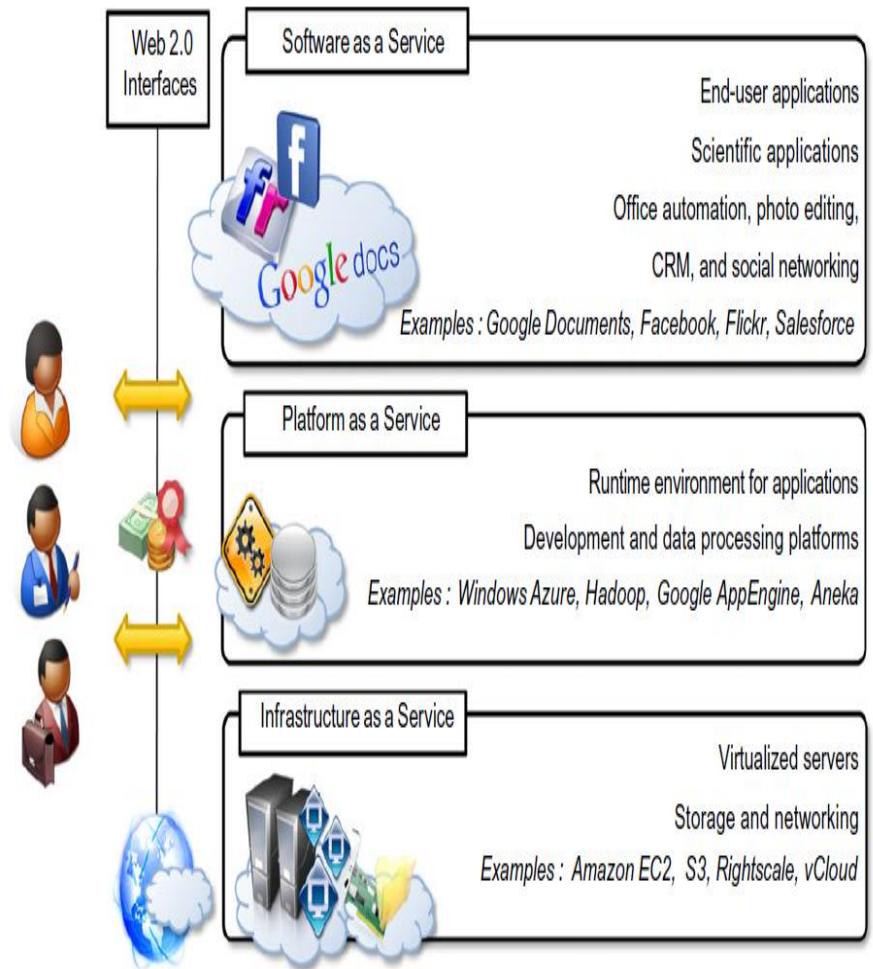
Cloud Computing Reference Model

- At the base of the stack, Infrastructure-as-a-Service solutions deliver infrastructure on demand in the form of *virtual hardware*, *storage*, and *networking*
- Virtual hardware is utilized to provide compute on demand in the form of virtual machine instances
- Users are given tools and interfaces to configure the software stack installed in the virtual machine
- Virtual storage is delivered in the form of raw disk space or object store
- Platform-as-a-Service solutions are the next step in the stack
- They deliver scalable and elastic runtime environments on demand and host the execution of applications
- It is the responsibility of the service provider to provide scalability and to manage fault tolerance, while users are requested to focus on the logic of the application developed by leveraging the provider's APIs and libraries

Cloud Computing Reference Model

- At the top of the stack Software-as-a-Service solutions provide applications and services on demand
- Most of the common functionalities of desktop applications—such as office automation, document management, photo editing, and customer relationship management (CRM) software—are replicated on the provider's infrastructure and made more scalable and accessible through a browser on demand
- These applications are shared across multiple users whose interaction is isolated from the other users
- The SaaS layer is also the area of social networking Websites, which leverage cloud-based infrastructures to sustain the load generated by their popularity

Characteristics and Benefits

- Cloud computing has some interesting characteristics that bring benefits to both cloud service consumers (CSCs) and cloud service providers (CSPs)
    - No up-front commitments
    - On-demand access
    - Nice pricing
    - Simplified application acceleration and scalability
    - Efficient resource allocation
    - Energy efficiency
    - Seamless creation and use of third-party services
- The most evident benefit from the use of cloud computing systems and technologies is the increased economical return due to the reduced maintenance costs and operational costs related to IT software and infrastructure
- Software and infrastructure, are turned into utility costs, which are paid for as long as they are used, not paid for up front

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Computing Platforms and Technologies

- Amazon web services (AWS):
  - AWS offers comprehensive cloud IaaS services ranging from virtual compute, storage, and networking to complete computing stacks. AWS is mostly known for its compute and storage-on- demand services, namely Elastic Compute Cloud(EC2) and Simple Storage Service(S3).
  - EC2 provides users with customizable virtual hardware that can be used as the base infrastructure for deploying computing systems on the cloud.
  - It is possible to choose from a large variety of virtual hardware configurations, including GPU and cluster instances
- Google AppEngine :
  - Google AppEngine is a scalable runtime environment mostly devoted to executing Web applications
  - These take advantage of the large computing infrastructure of Google to dynamically scale as the demand varies over time

Computing Platforms and Technologies

- Microsoft Azure
  - Microsoft Azure is a cloud operating system and a platform for developing applications in the cloud.
  - It provides a scalable runtime environment for Web applications and distributed applications in general
- Hadoop:
  - Apache Hadoop is an open-source framework that is suited for processing large data sets on commodity hardware.
  - Hadoop is an implementation of MapReduce, an application programming model developed by Google, which provides two fundamental operations for data processing: map and reduce
- Force.com and Salesforce.com :
  - Force.com is a cloud computing platform for developing social enterprise applications. The plat- form is the basis for SalesForce.com a Software-as-a-Service solution for customer relationship management

Computing Platforms and Technologies

- Manjrasoft Aneka
  - Manjrasoft Aneka is a cloud application platform for rapid creation of scalable applications and their deployment on various types of clouds in a seamless and elastic manner
  - It supports a collection of programming abstractions for developing applications and a distributed runtime environment that can be deployed on heterogeneous hardware (clusters, networked desktop computers, and cloud resources)
- These platforms are key examples of technologies available for cloud computing. They mostly fall into the three major market segments identified in the reference model