# **Cloud Computing Tutorial**

Cloud computing is a virtualization-based technology that allows us to create, configure, and customize applications via an internet connection. The cloud technology includes a development platform, hard disk, software application, and database.

**What is Cloud Computing**

The term cloud refers to a network or the internet. It is a technology that uses remote servers on the internet to store, manage, and access data online rather than local drives. The data can be anything such as files, images, documents, audio, video, and more.

There are the following operations that we can do using cloud computing:

* Developing new applications and services
* Storage, back up, and recovery of data
* Hosting blogs and websites
* Delivery of software on demand
* Analysis of data
* Streaming videos and audios

**Why Cloud Computing?**

Small as well as large IT companies, follow the traditional methods to provide the IT infrastructure. That means **for any IT company, we need a Server Room that is the basic need of IT companies**.

In that server room, there should be a database server, mail server, networking, firewalls, routers, modem, switches, QPS (Query Per Second means how much queries or load will be handled by the server), configurable system, high net speed, and the maintenance engineers.

To establish such IT infrastructure, we need to spend lots of money. To overcome all these problems and to reduce the IT infrastructure cost, Cloud Computing comes into existence.

## Characteristics of Cloud Computing

1. **Agility**
2. **High availability and reliability**
3. **High Scalability**
4. **Multi-Sharing**
5. **Device and Location Independence**
6. **Maintenance**
7. **Low Cost**
8. **Services in the pay-per-use mode**

**Advantages of Cloud Computing**

1) Back-up and restore data

2) Improved collaboration

3) Excellent accessibility

4) Low maintenance cost

5) Mobility

6) Services in the pay-per-use model

7) Unlimited storage capacity

8) Data security

**Disadvantages of Cloud Computing**

1) Internet Connectivity

2) Vendor lock-in

3) Limited Control

4) Security

# **Cloud Computing Architecture**

As we know, cloud computing technology is used by both small and large organizations to **store the information** in cloud and **access** it from anywhere at anytime using the internet connection.

Cloud computing architecture is a combination of **service-oriented architecture** and **event-driven architecture**.

Cloud computing architecture is divided into the following two parts -

* Front End
* Back End

The below diagram shows the architecture of cloud computing -

### **Front End**

The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

### **Back End**

The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.

#### **Note: Both front end and back end are connected to others through a network, generally using the internet connection.**

## Components of Cloud Computing Architecture

There are the following components of cloud computing architecture -

**1. Client Infrastructure**

Client Infrastructure is a Front end component. It provides GUI (Graphical User Interface)  to interact with the cloud.

**2. Application**

The application may be any software or platform that a client wants to access.

**3. Service**

A Cloud Services manages that which type of service you access according to the client’s requirement.

Cloud computing offers the following three type of services:

**i. Software as a Service (SaaS) –**It is also known as **cloud application services**. Mostly, SaaS applications run directly through the web browser means we do not require to download and install these applications. Some important example of SaaS is given below –

**Example:** Google Apps, Salesforce Dropbox, Slack, Hubspot, Cisco WebEx.

**ii. Platform as a Service (PaaS) –** It is also known as **cloud platform** **services**. It is quite similar to SaaS, but the difference is that PaaS provides a platform for software creation, but using SaaS, we can access software over the internet without the need of any platform.

**Example:** Windows Azure, Force.com, Magento Commerce Cloud, OpenShift.

**iii. Infrastructure as a Service (IaaS) –**It is also known as **cloud infrastructure services**. It is responsible for managing applications data, middleware, and runtime environments.

**Example:** Amazon Web Services (AWS) EC2, Google Compute Engine (GCE), Cisco Metapod.

**4. Runtime Cloud**

Runtime Cloud provides the **execution and runtime environment** to the virtual machines.

**5. Storage**

Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage data.

**6. Infrastructure**

It provides services on the **host level**, **application level**, and **network level**. Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support the cloud computing model.

**7. Management**

Management is used to manage components such as application, service, runtime cloud, storage, infrastructure, and other security issues in the backend and establish coordination between them.

**8. Security**

Security is an in-built back end component of cloud computing. It implements a security mechanism in the back end.

**9. Internet**

The Internet is medium through which front end and back end can interact and communicate with each other.

# **Cloud Computing Technologies**

A list of cloud computing technologies are given below -

## Virtualization

Virtualization is the process of creating a virtual environment to run multiple applications and operating systems on the same server. The virtual environment can be anything, such as a single instance or a combination of many operating systems, storage devices, network application servers, and other environments.

The concept of Virtualization in cloud computing increases the use of virtual machines. A virtual machine is a software computer or software program that not only works as a physical computer but can also function as a physical machine and perform tasks such as running applications or programs as per the user's demand.

### **Types of Virtualization**

A list of types of Virtualization is given below -

1. Hardware virtualization
2. Server virtualization
3. Storage virtualization
4. Operating system virtualization
5. Data Virtualization

## Service-Oriented Architecture (SOA)

Service-Oriented Architecture (SOA) allows organizations to access **on-demand** cloud-based computing solutions according to the change of business needs. It can work without or with cloud computing. The advantages of using SOA is that it is easy to maintain, platform independent, and highly scalable.

Service Provider and Service consumer are the two major roles within SOA.

### **Applications of Service-Oriented Architecture**

There are the following applications of Service-Oriented Architecture -

* It is used in the healthcare industry.
* It is used to create many mobile applications and games.
* In the air force, SOA infrastructure is used to deploy situational awareness systems.

The service-oriented architecture is shown below:

## Grid Computing

Grid computing is also known as **distributed computing**. It is a processor architecture that combines various different computing resources from multiple locations to achieve a common goal. In grid computing, the grid is connected by parallel nodes to form a computer cluster. These computer clusters are in different sizes and can run on any operating system.

Grid computing contains the following three types of machines -

1. **Control Node:** It is a group of server which administrates the whole network.
2. **Provider:** It is a computer which contributes its resources in the network resource pool.
3. **User:** It is a computer which uses the resources on the network.

Mainly, grid computing is used in the **ATMs, back-end infrastructures,** and **marketing research**.

## Utility Computing

Utility computing is the most trending IT service model. It provides on-demand computing resources (computation, storage, and programming services via API) and infrastructure based on the **pay per use** method. It minimizes the associated costs and maximizes the efficient use of resources. The advantage of utility computing is that it reduced the IT cost, provides greater flexibility, and easier to manage.

Large organizations such as **Google** and **Amazon** established their own utility services for computing storage and application.

#### **Note: Grid computing, Cloud computing, as well as managed IT services follow the concept of utility computing.**

# **Difference between Cloud Computing and Grid Computing**

## Cloud Computing

Cloud computing uses a **client-server** architecture to deliver computing resources such as servers, storage, databases, and software over the cloud (Internet) with pay-as-you-go pricing.

Cloud computing becomes a very popular option for organizations by providing various advantages, including cost-saving, increased productivity, efficiency, performance, data back-ups, disaster recovery, and security.

## Grid Computing

Grid computing is also called as "**distributed computing**." It links multiple computing resources (PC's, workstations, servers, and storage elements) together and provides a mechanism to access them.

The main advantages of grid computing are that it increases user productivity by providing transparent access to resources, and work can be completed more quickly.

Let's understand the difference between cloud computing and grid computing.

|  |  |
| --- | --- |
| **Cloud Computing** | **Grid Computing** |
| Cloud Computing follows client-server computing architecture. | Grid computing follows a distributed computing architecture. |
| Scalability is high. | Scalability is normal. |
| Cloud Computing is more flexible than grid computing. | Grid Computing is less flexible than cloud computing. |
| Cloud operates as a centralized management system. | Grid operates as a decentralized management system. |
| In cloud computing, cloud servers are owned by infrastructure providers. | In Grid computing, grids are owned and managed by the organization. |
| Cloud computing uses services like Iaas, PaaS, and SaaS. | Grid computing uses systems like distributed computing, distributed information, and distributed pervasive. |
| Cloud Computing is Service-oriented. | Grid Computing is Application-oriented. |
| It is accessible through standard web protocols. | It is accessible through grid middleware. |

# **Types of Cloud**

# **Public Cloud**

* Public Cloud provides a **shared platform** that is accessible to the **general public** through an Internet connection.
* Public cloud operated on the **pay-as-per-use model** and administrated by the **third party**, i.e., Cloud service provider.
* In the Public cloud, the same storage is being used by multiple users at the same time.
* Public cloud is **owned, managed,** and **operated** by businesses, universities, government organizations, or a combination of them.
* Amazon Elastic Compute Cloud (EC2), Microsoft Azure, IBM's Blue Cloud, Sun Cloud, and Google Cloud are examples of the public cloud.

**Advantages of Public Cloud**

There are the following advantages of public cloud -

**1) Low Cost**

Public cloud has a lower cost than private, or hybrid cloud, as it shares the same resources with a large number of consumers.

**2) Location Independent**

Public cloud is location independent because its services are offered through the internet.

**3) Save Time**

In Public cloud, the cloud service provider is responsible for the manage and maintain data centers in which data is stored, so the cloud user can save their time to establish connectivity, deploying new products, release product updates, configure, and assemble servers.

**4) Quickly and easily set up**

Organizations can easily buy public cloud on the internet and deployed and configured it remotely through the cloud service provider within a few hours.

**5) Business Agility**

Public cloud provides an ability to elastically re-size computer resources based on the organization's requirements.

**6) Scalability and reliability**

Public cloud offers scalable (easy to add and remove) and reliable (24\*7 available) services to the users at an affordable cost.

**Disadvantages of Public Cloud**

**1) Low Security**

Public Cloud is less secure because resources are shared publicly.

**2) Performance**

In the public cloud, performance depends upon the speed of internet connectivity.

**3) Less customizable**

Public cloud is less customizable than the private cloud.

# **Private Cloud**

* Private cloud is also known as an **internal cloud** or **corporate cloud**.
* Private cloud provides computing services to a **private internal network (within the organization)** and **selected users** instead of the general public.
* Private cloud provides a **high level of security** and **privacy** to data through firewalls and internal hosting. It also ensures that operational and sensitive data are not accessible to third-party providers.
* HP Data Centers, Microsoft, Elastra-private cloud, and Ubuntu are the example of a private cloud.

## Advantages of Private cloud

There are the following advantages of Private Cloud -

### **1) More Control**

Private clouds have more control over their resources and hardware than public clouds because it is only accessed by selected users.

### **2) Security & privacy**

Security & privacy are one of the big advantages of cloud computing. Private cloud improved the security level as compared to the public cloud.

### **3) Improved performance**

Private cloud offers better performance with improved speed and space capacity.

## Disadvantages of Private Cloud

### **1) High cost**

The cost is higher than a public cloud because set up and maintain hardware resources are costly.

### **2) Restricted area of operations**

As we know, private cloud is accessible within the organization, so the area of operations is limited.

### **3) Limited scalability**

Private clouds are scaled only within the capacity of internal hosted resources.

### **4) Skilled people**

Skilled people are required to manage and operate cloud services.

# **Hybrid Cloud**

* Hybrid cloud is a combination of **public and private** clouds.  
  **Hybrid cloud = public cloud + private cloud**
* The main aim to combine these cloud (Public and Private) is to create a unified, automated, and well-managed computing environment.
* In the Hybrid cloud, **non-critical activities** are performed by the **public cloud** and **critical activities** are performed by the **private cloud**.
* Mainly, a hybrid cloud is used in finance, healthcare, and Universities.
* The best hybrid cloud provider companies are **Amazon, Microsoft, Google, Cisco,** and **NetApp**.

## Advantages of Hybrid Cloud

There are the following advantages of Hybrid Cloud -

### **1) Flexible and secure**

It provides flexible resources because of the public cloud and secure resources because of the private cloud.

### **2) Cost effective**

Hybrid cloud costs less than the private cloud. It helps organizations to save costs for both infrastructure and application support.

### **3) Cost effective**

It offers the features of both the public as well as the private cloud. A hybrid cloud is capable of adapting to the demands that each company needs for space, memory, and system.

### **4) Security**

Hybrid cloud is secure because critical activities are performed by the private cloud.

### **5) Risk Management**

Hybrid cloud provides an excellent way for companies to manage the risk.

## Disadvantages of Hybrid Cloud

### **1) Networking issues**

In the Hybrid Cloud, networking becomes complex because of the private and the public cloud.

### **2) Infrastructure Compatibility**

Infrastructure compatibility is the major issue in a hybrid cloud. With dual-levels of infrastructure, a private cloud controls the company, and a public cloud does not, so there is a possibility that they are running in separate stacks.

### **3) Reliability**

The reliability of the services depends on cloud service providers.

# **Community Cloud**

Community cloud is a cloud infrastructure that allows systems and services to be accessible by a group of several organizations to share the information. It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.

**Example:** Our government organization within India may share computing infrastructure in the cloud to manage data.

## Advantages of Community Cloud

There are the following advantages of Community Cloud -

### **Cost effective**

Community cloud is cost effective because the whole cloud is shared between several organizations or a community.

### **Flexible and Scalable**

The community cloud is flexible and scalable because it is compatible with every user. It allows the users to modify the documents as per their needs and requirement.

### **Security**

Community cloud is more secure than the public cloud but less secure than the private cloud.

### **Sharing infrastructure**

Community cloud allows us to share cloud resources, infrastructure, and other capabilities among various organizations.

## Disadvantages of Community Cloud

There are the following disadvantages of Community Cloud -

* Community cloud is not a good choice for every organization.
* Slow adoption to data
* The fixed amount of data storage and bandwidth is shared among all community members.
* Community Cloud is costly than the public cloud.
* Sharing responsibilities among organizations is difficult.

# **Cloud Service Models**

There are the following three types of cloud service models -

## Infrastructure as a Service (IaaS)

IaaS is also known as **Hardware as a Service (HaaS)**. It is a computing infrastructure managed over the internet. The main advantage of using IaaS is that it helps users to avoid the cost and complexity of purchasing and managing the physical servers.

### **Characteristics of IaaS**

There are the following characteristics of IaaS -

* Resources are available as a service
* Services are highly scalable
* Dynamic and flexible
* GUI and API-based access
* Automated administrative tasks

**Example:** DigitalOcean, Linode, Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), Rackspace, and Cisco Metacloud.

IaaS provider provides the following services -

1. **Compute:** Computing as a Service includes virtual central processing units and virtual main memory for the Vms that is provisioned to the end- users.
2. **Storage:** IaaS provider provides back-end storage for storing files.
3. **Network:** Network as a Service (NaaS) provides networking components such as routers, switches, and bridges for the Vms.
4. **Load balancers:** It provides load balancing capability at the infrastructure layer.

## Platform as a Service (PaaS)

PaaS cloud computing platform is created for the programmer to develop, test, run, and manage the applications.

### **Characteristics of PaaS**

There are the following characteristics of PaaS -

* Accessible to various users via the same development application.
* Integrates with web services and databases.
* Builds on virtualization technology, so resources can easily be scaled up or down as per the organization's need.
* Support multiple languages and frameworks.
* Provides an ability to "**Auto-scale**".

**Example:** AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, Magento Commerce Cloud, and OpenShift.

PaaS providers provide the Programming languages, Application frameworks, Databases, and Other tools:

### **1. Programming languages**

PaaS providers provide various programming languages for the developers to develop the applications. Some popular programming languages provided by PaaS providers are Java, PHP, Ruby, Perl, and Go.

### **2. Application frameworks**

PaaS providers provide application frameworks to easily understand the application development. Some popular application frameworks provided by PaaS providers are Node.js, Drupal, Joomla, WordPress, Spring, Play, Rack, and Zend.

### **3. Databases**

PaaS providers provide various databases such as ClearDB, PostgreSQL, MongoDB, and Redis to communicate with the applications.

### **4. Other tools**

PaaS providers provide various other tools that are required to develop, test, and deploy the applications.

## Software as a Service (SaaS)

SaaS is also known as "**on-demand software**". It is a software in which the applications are hosted by a cloud service provider. Users can access these applications with the help of internet connection and web browser.

### **Characteristics of SaaS**

There are the following characteristics of SaaS -

* Managed from a central location
* Hosted on a remote server
* Accessible over the internet
* Users are not responsible for hardware and software updates. Updates are applied automatically.
* The services are purchased on the pay-as-per-use basis

**Example:** BigCommerce, Google Apps, Salesforce, Dropbox, ZenDesk, Cisco WebEx, ZenDesk, Slack, and GoToMeeting.

There are the following services provided by SaaS providers -

**Business Services** - SaaS Provider provides various business services to start-up the business. The SaaS business services include **ERP** (Enterprise Resource Planning), **CRM** (Customer Relationship Management), **billing**, and **sales**.

**Document Management** - SaaS document management is a software application offered by a third party (SaaS providers) to create, manage, and track electronic documents.

**Example:** Slack, Samepage, Box, and Zoho Forms.

**Social Networks** - As we all know, social networking sites are used by the general public, so social networking service providers use SaaS for their convenience and handle the general public's information.

**Mail Services** - To handle the unpredictable number of users and load on e-mail services, many e-mail providers offering their services using SaaS.

# **Cloud Service Provider Companies**

Cloud Service providers (CSP) offers various services such as **Software as a Service**, **Platform as a service**, **Infrastructure as a service**, **network services**, **business applications**, **mobile applications**, and **infrastructure** in the cloud. The cloud service providers host these services in a data center, and users can access these services through cloud provider companies using an Internet connection.

There are the following Cloud Service Providers Companies -

## Amazon Web Services (AWS)

[AWS](https://www.javatpoint.com/aws-tutorial) (Amazon Web Services) is a **secure cloud service platform** provided by **Amazon**. It offers various services such as database storage, computing power, content delivery, Relational Database, Simple Email, Simple Queue, and other functionality to increase the organization's growth.

### **Features of AWS**

AWS provides various powerful features for building scalable, cost-effective, enterprise applications. Some important [features of AWS](https://www.javatpoint.com/features-of-aws) is given below-

* AWS is **scalable** because it has an ability to scale the computing resources up or down according to the organization's demand.
* AWS is **cost-effective** as it works on a **pay-as-you-go** pricing model.
* It provides various flexible storage options.
* It offers various **security services** such as infrastructure security, data encryption, monitoring & logging, identity & access control, penetration testing, and DDoS attacks.
* It can efficiently manage and secure Windows workloads.

## 2. Microsoft Azure

[Microsoft Azure](https://www.javatpoint.com/microsoft-azure) is also known as **Windows Azure**. It supports various operating systems, databases, programming languages, frameworks that allow [IT](https://www.javatpoint.com/it-full-form) professionals to easily build, deploy, and manage applications through a worldwide network. It also allows users to create different groups for related utilities.

### **Features of Microsoft Azure**

* Microsoft Azure provides **scalable**, **flexible**, and **cost-effective**
* It allows developers to quickly manage applications and websites.
* It managed each resource individually.
* Its IaaS infrastructure allows us to launch a general-purpose virtual machine in different platforms such as Windows and Linux.
* It offers a **Content Delivery System (CDS)** for delivering the Images, videos, audios, and applications.

## 3. Google Cloud Platform

Google cloud platform is a product of **Google**. It consists of a set of physical devices, such as computers, hard disk drives, and virtual machines. It also helps organizations to simplify the migration process.

### **Features of Google Cloud**

* Google cloud includes various **big data services** such as Google BigQuery, Google CloudDataproc, Google CloudDatalab, and Google Cloud Pub/Sub.
* It provides various services related to **networking**, including Google Virtual Private Cloud (VPC), Content Delivery Network, Google Cloud Load Balancing, Google Cloud Interconnect, and Google Cloud DNS.
* It offers various **scalable** and **high-performance**
* GCP provides various **serverless services** such as Messaging, Data Warehouse, Database, Compute, Storage, Data Processing, and Machine learning (ML)
* It provides a free cloud shell environment with Boost Mode.