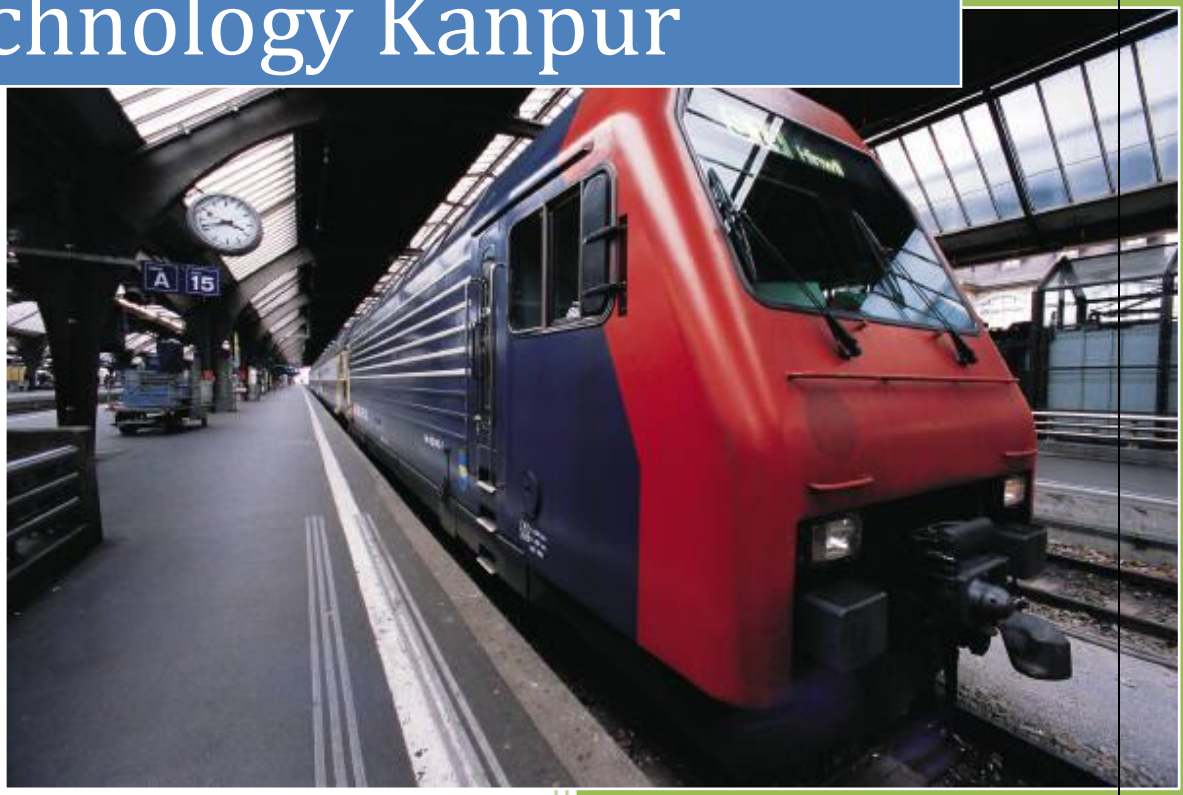
Cloud Computing, KOE081

2023

Vision Institute Of Technology Kanpur



By Kaptan Yadav

HOD, Electrical & Electronics Engineering

2/6/2023

KOE081: CLOUD COMPUTING

Unit-1

Introduction: Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed, History of Cloud Computing - Cloud Architecture **- Types of Clouds** - Business models around Clouds – Major Players in Cloud Computing, issues in Clouds - Eucalyptus - Nimbus - Open Nebula, CloudSim.

Unit-2

Types of Cloud services: Software as a Service, Platform as a Service –Infrastructure as a Service - Database as a Service - Monitoring as a Service –Communication as services. Service providers- Google, Amazon, Microsoft Azure, IBM, Sales force.

Unit-3

Collaborating Using Cloud Services:

Email Communication over the Cloud - CRM Management – Project Management-Event Management - Task Management – Calendar - Schedules - Word Processing – Presentation – Spreadsheet - Databases – Desktop - Social Networks and Groupware.

Unit-4

Virtualization for Cloud: Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization –System VM, Process VM, Virtual Machine monitor – Virtual machine properties - Interpretation and binary translation, HLL VM - supervisors – Xen, KVM, VMware,Virtual Box, Hyper-V.

Unit-5

Security, Standards and Applications:

Security in Clouds: Cloud security challenges – Software as a Service Security, Common Standards: The Open Cloud Consortium – The Distributed management Task Force – Standards for application Developers – Standards for Messaging – Standards for Security, End user access to cloud computing, Mobile Internet devices and the cloud. Hadoop – MapReduce – Virtual Box — Google App Engine – Programming Environment for Google App Engine

Unit 1st & 2nd

Access refers to the ability to enter, use, or control something, especially a computer system, database, or device. In a broader sense, it can also refer to the opportunity or permission to approach, enter, or use something.

Docker is a tool that helps developers to create, run, and manage applications in a container. Containers are like packages that hold the code and resources needed for an application to run. Using Docker in the cloud makes it easier for developers to move their applications between different environments, like from their own computer to a cloud server, without having to worry about any differences in those environments. It makes it easier to manage and run applications in the cloud.

Cloud Computing: Cloud computing is a way to use and access technology services over the internet, instead of having them on your own computer or device.
It allows you to store, manage, and process data and access different types of services, like email, storage, and computing power, on servers in a network of computers maintained by companies like Amazon, Google, and Microsoft. You can access these services from anywhere, as long as you have an internet connection. This makes it easier and more convenient for people and businesses to use technology resources, and can also save them money and time.

Why Cloud computing

- Developing in the cloud enables users to get their applications to market quickly.
- Hardware failures do not result in data loss because of networked backups.
- Cloud computing uses remote resources, saving organizations the cost of servers and other equipments

The cloud Computing Have following basic characteristics:

(a) **Elasticity and the ability to scale up and down**
Scalability means that an application can scale when additional users are added and when the application requirements change. This ability to scale is achieved by providing elasticity

(b) **Self-service provisioning**
Customers can easily get cloud services without going through a lengthy process. The customer simply requests an amount of computing, storage, software, process, or other resources from the service provider. While the on-demand provisioning capabilities of cloud services eliminate many time delays, an organization still needs to do its homework. These services aren't free; needs and requirements must be determined before capability is automatically provisioned

(c) Application programming interfaces (APIs)
Cloud services need to have standardized APIs. These interfaces provide the instructions on how two application or data sources can communicate with each other. A standardized interface lets the customer more easily link a cloud service, such as a customer relationship management system with a financial accounts management system, without having to resort to custom programming.

(d) **Billing and metering of services**
A cloud environment needs a built-in service that bills customers. And to calculate that bill, usage has to be metered (tracked). Even free cloud services (such as Google's Gmail or Zoho's Internet-based office applications) are metered. In addition to these characteristics, cloud computing must have **two overarching requirements to be effective:**
• A comprehensive approach to service management
• A well-defined process for security management

(e) Security

Applications:

- **Email:**
  Gmail, Yahoo mail.
- **Online Collaboration tools :**
  Google docs for collaboration on documents ,Google Hangouts for video conferencing
- **Big Data Analytics :**
  Provides a cost effective and scalable infrastructure to support big data and business analytics.
- **Test and Development :**
  Now readily available environments tailored for your needs at your fingertips.
- **Storage**

Advantages of Cloud Computing

- Lower computer costs
- Instant software updates
- Unlimited storage capacity
- Increased data reliability
- Universal document access
- Device independence
- Lowers the outlay expense for start up companies
- Easier group collaboration

Disadvantages of Cloud Computing

- Requires a constant Internet connection
- Does not work well with low-speed connections
- Governance and Regulatory compliance.
  Not all service providers have well-defined service-level agreements.
- Stored data might not be secure:
  Limited knowledge of the physical location of stored data
  Limited capabilities for monitoring access to applications hosted on cloud.

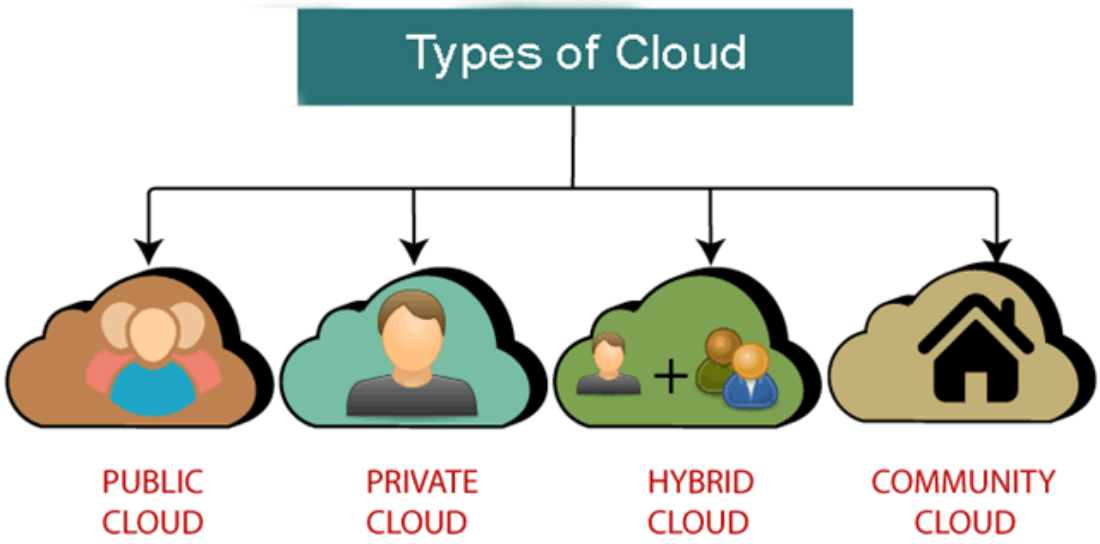
Real-World Examples of Cloud Computing

- Dropbox, Gmail, Facebook.
- Maropost for Marketing, Hubspot, Adobe Marketing Cloud.
- SlideRocket, Ratatype, Amazon Web Services.
- ClearDATA, Dell's Secure Healthcare Cloud, IBM Cloud.

Types Of Cloud : There are Three main types of cloud

- Public Cloud

- Private Cloud
- Hybrid Cloud



Public Cloud:

Public cloud, or external cloud, is the most common form of cloud computing, in which services are made available to the general public. Public cloud refers to a type of cloud computing where a service provider makes resources, such as servers, storage, and applications, available to the general public over the internet. Users can access these resources in a pay-as-you-go manner and do not need to invest in expensive hardware and infrastructure. Examples of public cloud providers include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud.

- Customers do not have any control over the location of the infrastructure.
- The cost is shared by all users and is either free or in the form of a license policy like pay per user.
- Public clouds are great for organizations that require managing the host application and the various applications users use.

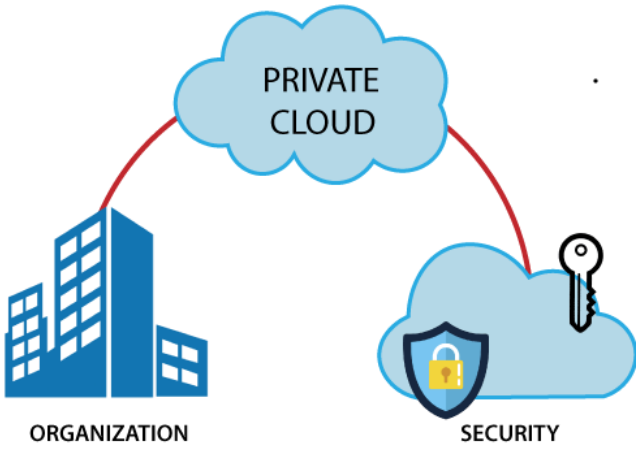
Advantages of public clouds:

- **Lower costs—**no need to purchase hardware or software and you pay only for the service you use.
- **No maintenance—**your service provider provides the maintenance.
- **Near-unlimited scalability—**on-demand resources are available to meet your business needs.
- **High reliability—**a vast network of servers ensures against failure.

Private Cloud

A private cloud consists of cloud computing resources used exclusively by one business or organisation. The private cloud can be physically located at your organisation's on-site datacenter or it can be hosted by a third-party service provider. But in a private cloud, the services and infrastructure are always maintained on a private network and the hardware and software are dedicated solely to your organisation.

In this way, a private cloud can make it easier for an organization to customize its resources to meet specific IT requirements. Private clouds are often used by government agencies, financial institutions, any other mid- to large-size organizations with business-critical operations seeking enhanced control over their environment.



Advantages of a private cloud:

More flexibility—organization can customize its cloud environment to meet specific business needs.
More control—resources are not shared with others, so higher levels of control and privacy are possible.
More scalability—private clouds often offer more scalability compared to on-premises infrastructure
Security—It gives organizations greater control over security and data safeguarded by a firewall and managed internally.
It can be hosted internally or externally.
Private clouds are great for organizations that have high-security demands, high management demands, and uptime requirements.

Examples of private cloud vendors

Hewlett Packard Enterprise (HPE), Dell, Oracle, IBM

	Public Cloud	**Private Cloud**
Infrastructure Owner	Third party (cloud provider)	Enterprise
Scalability Control & Management	Unlimited and On-demand only manipulate the virtual machines, resulting in less management burden.	Limited to the installed infra-structures, high level of control over the resources and need more expertise to manage them.
Cost	Lower Cost	High cost including: Space, cooling, Energy consumption and hardware cost

Performance	Hard to achieve guaranteed performance	Guaranteed performance
Security	Less secure	Highly Secure

Hybrid Cloud

A hybrid cloud is a type of cloud computing that combines on a private cloud—with a public cloud. Hybrid clouds allow data and apps to move between the two environments.

Hybrid cloud = public cloud + private cloud

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**.

A hybrid cloud platform gives organizations many advantages—such as greater flexibility, more deployment options, security, compliance and getting more value from their existing infrastructure. Organizations gain the flexibility and innovation the public cloud provides by running certain workloads in the cloud while keeping highly sensitive data in their own datacenter to meet client needs or regulatory requirements.

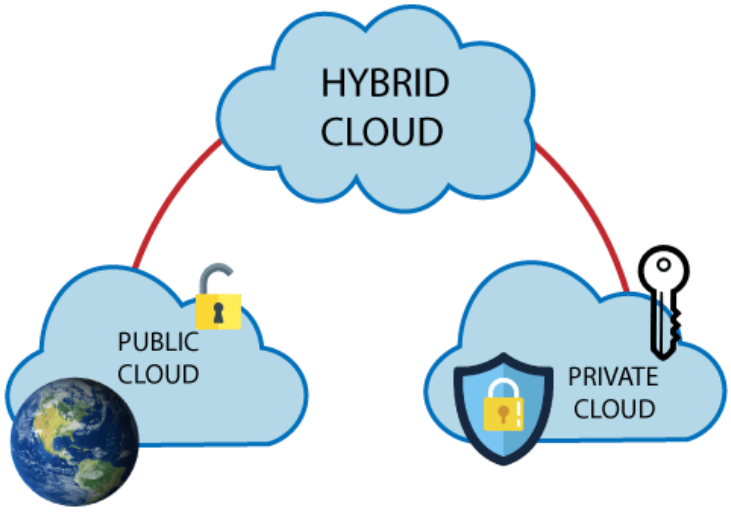
Advantages of the hybrid cloud:

Control—The organization can maintain a private infrastructure for sensitive assets or workloads that require low latency.

Flexibility—They can take advantage of additional resources in the public cloud when you need them.

Cost-effectiveness—with the ability to scale to the public cloud, you pay for extra computing power only when needed.

Ease—transitioning to the cloud does not have to be overwhelming because you can migrate gradually—phasing in workloads over time.



Disadvantages of Hybrid Cloud

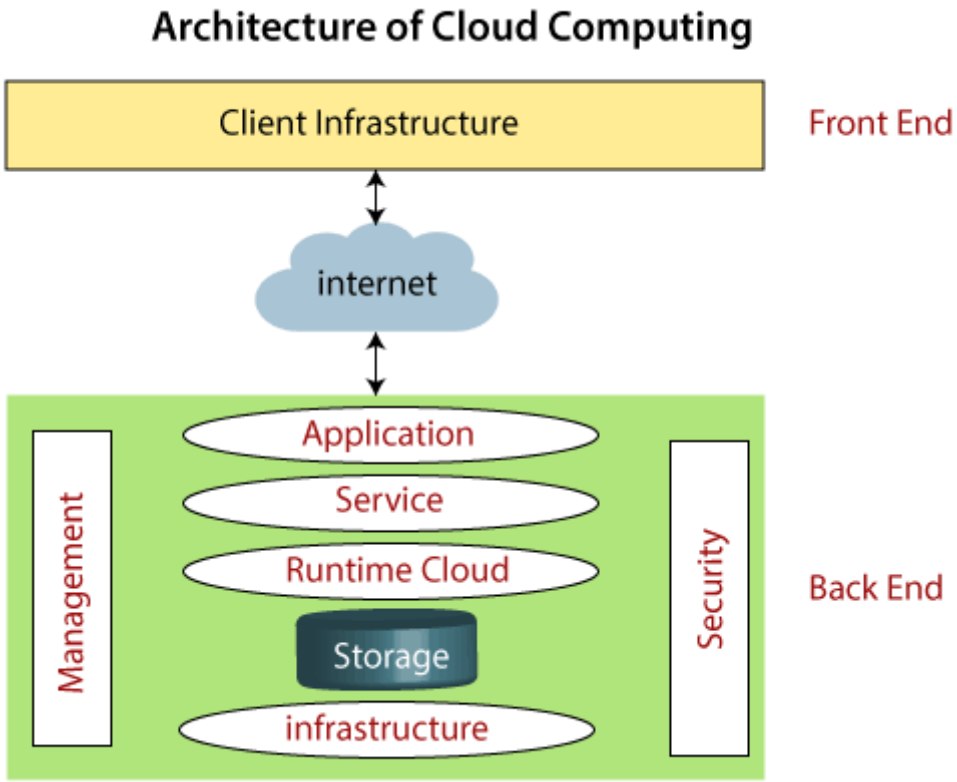
- **Networking issues**
  In the Hybrid Cloud, networking becomes complex because of the private and the public cloud.
- **Infrastructure Compatibility**
  Infrastructure compatibility is the major issue in a hybrid cloud. With dual-levels of infrastructure, a private cloud controls the company, and a public cloud does not, so there is a possibility that they are running in separate stacks**.**

- **Reliability**
  The reliability of the services depends on cloud service providers.
  Examples Of Hybrid Cloud :
  Amazon, Microsoft, Google, Cisco, and NetApp.

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 Platform: The front refers to the client part of cloud computing system. It consists of interfaces & applications that are required to access the cloud computing platforms like web browser.
The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

Back end platform:

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:

1) **Client Infrastructure:** Client Infrastructure is a Front end component. It provides GUI (Graphical User Interface) to interact with the cloud.
   Thin Clients : These clients neither have hard drives nor have DVD rom drives and largely depend on server.
   Thick Clients : Self sufficient in terms of accessories.
   Mobile Clients : Laptops, Smartphone, this category of clients demands for higher speed & high level of security.
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.
   ii. 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.

Management software : Management software in cloud computing architecture refers to software tools and platforms that are used to manage cloud computing resources and services. Cloud computing management software typically includes a set of tools that allow cloud administrators to monitor, provision, configure, and manage cloud resources and services.

Popular Management Software:

- Eucalyptus
- Nimbus,
- CloudSim
- Open Nebula

Eucalyptus

Eucalyptus basically provides architecture for designing our Own private cloud

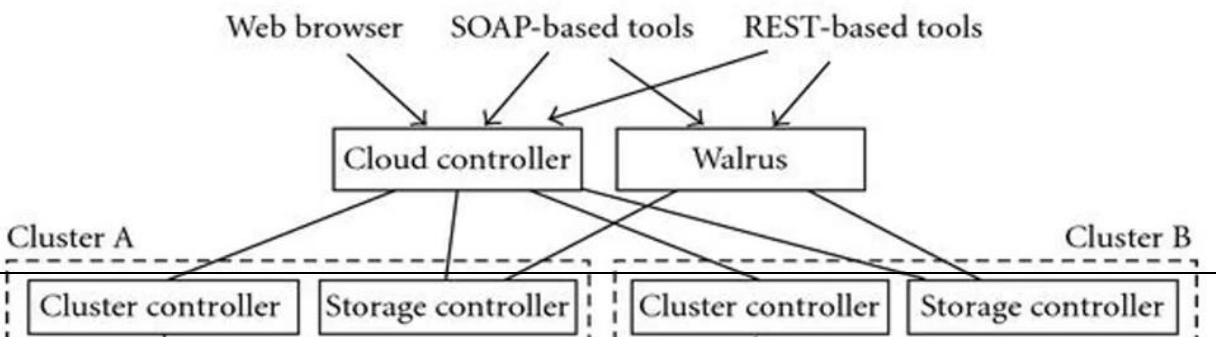
Eucalyptus is an open source software platform for creating and managing private and hybrid cloud computing infrastructure. The name Eucalyptus stands for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems, and it is designed to provide a seamless interface between private cloud computing infrastructure and public cloud platforms like Amazon Web Services (AWS).

It Can be used by organizations to create and manage private or hybrid cloud environments. Some of the organizations that have used or are currently using Eucalyptus as a cloud management software include:

NASA: The National Aeronautics and Space Administration (NASA) used Eucalyptus as the basis for their cloud computing platform, which was used to manage their scientific data and computing infrastructure.

University of California: The University of California system used Eucalyptus to create a private cloud environment for their research community, which was used for running scientific applications and simulations.

These are just a few examples of the organizations that have used Eucalyptus as a cloud management software. Eucalyptus has been used by a wide range of organizations, from small businesses to large enterprises, and has been adopted by a number of government agencies and research institutions.



History of Cloud Computing

- ✓ Before emerging the cloud computing, there was Client/Server computing which is basically a centralized storage in which all the software applications, all the data and all the controls are resided on the server side.
- ✓ If a single user wants to access specific data or run a program, he/she need to connect to the server and then gain appropriate access, and then he/she can do his/her business.
- ✓ Then after, distributed computing came into picture, where all the computers are networked together and share their resources when needed.
- ✓ In 1999, Salesforce.com started delivering of applications to users using a simple website. The applications were delivered to enterprises over the Internet, and this way the dream of computing sold as utility were true.
- ✓ In 2002, Amazon started Amazon Web Services, providing services like storage, computation and even human intelligence. However, only starting with the launch of the Elastic Compute Cloud in 2006 a truly commercial service open to everybody existed.
- ✓ In 2009, Google Apps also started to provide cloud computing enterprise applications.

Types of cloud services:

These are sometimes called the cloud computing stack, because they build on top of one another

Infrastructure-as-a-service (IaaS):

IaaS is the most basic category of cloud computing services that allows you rent IT infrastructure (servers, network, operating systems data storage drives or VM's) from a cloud provider on a pay-as-you-go basis.

Examples - Microsoft Azure, Amazon Web Services (AWS), Google Cloud Platform, Dropbox, etc.

Advantages of Iaas

Eliminates capital expense and reduces ongoing cost. IaaS sidesteps the upfront expense of setting up and managing an onsite data centre, making it an economical option for start-ups and businesses testing new ideas.

Improves business continuity and disaster recovery. Achieving high availability, business continuity and disaster recovery is expensive, since it requires a significant amount of technology and staff. But with the right service level agreement (SLA) in place, IaaS can reduce this cost and access applications and data as usual during a disaster or outage.

Innovate rapidly. As soon as you have decided to launch a new product or initiative, the necessary computing infrastructure can be ready in minutes or hours, rather than the days or weeks—and sometimes months—it could take to set up internally.

Respond quicker to shifting business conditions. IaaS enables you to quickly scale up resources to accommodate spikes in demand for your application— during the holidays, for example—then scale resources back down again when activity decreases to save money.

Focus on your core business. IaaS frees up your team to focus on your organisation's core business rather than on IT infrastructure.
Increase stability, reliability and supportability. With IaaS there is no need to maintain and upgrade software and hardware or troubleshoot equipment problems. With the appropriate agreement in place, the service provider assures that your infrastructure is reliable and meets SLAs.
Better security. With the appropriate service agreement, a cloud service provider can provide security for your applications and data that may be better than what you can attain in-house.
Gets new apps to users faster. Because you don't need to first set up the infrastructure before you can develop and deliver apps, you can get them to users faster with IaaS.

Platform as a service (PaaS) : Platform-as-a-service (PaaS) refers to the supply an on-demand environment for developing, testing, delivering and managing software applications. It is designed to quickly create web or mobile apps, without worrying about setting up or managing the underlying infrastructure of servers, storage, network and data bases needed for development.
Examples- AWS Elastic Beanstalk, Google App Engine, Microsoft Azure.

Advantages of PaaS

By delivering infrastructure as a service, PaaS offers the same advantages as IaaS. But its additional features—middleware, development tools and other business tools—give you more advantages:
Cut coding time. PaaS development tools can cut the time it takes to code new apps with pre-coded application components built into the platform, such as workflow, directory services, security features, search and so on.
Add development capabilities without adding staff. Platform as a Service components can give your development team new capabilities without your needing to add staff having the required skills.
Develop for multiple platforms—including mobile—more easily. Some service providers give you development options for multiple platforms, such as computers, mobile devices and browsers making cross-platform apps quicker and easier to develop.
Use sophisticated tools affordably. A pay-as-you-go model makes it possible for individuals or organisations to use sophisticated development software and business intelligence and analytics tools that they could not afford to purchase outright.
Support geographically distributed development teams. Because the development environment is accessed over the Internet, development teams can work together on projects even when team members are in remote locations.
Efficiently manage the application lifecycle. PaaS provides all of the capabilities that you need to support the complete web application lifecycle: building, testing, deploying, managing and updating within the same integrated environment.
Software as a service (SaaS): Software-as-a-service (SaaS) is a method for delivering software applications over the Internet as per the demand and on a subscription basis. SaaS helps you host and manage the software application and underlying infrastructure and handle any maintenance (software upgrades and security patching).
Examples - Microsoft Office 365, Google Drive, Adobe Creative Cloud, Gmail, Google Apps.etc.

Cloud Service Providers

Cloud Service providers are vendors which provide InformationTechnology (IT) as a service over the Internet. Cloud computing is a term which is used for storing and accessing data over the internet. Cloud companies helps you to access your data from a remote server.
There are many Cloud Service providers in the market:
1) Amazon Web Service (AWS)
2) Google Cloud Platform
3) Microsoft Azure
4) IBM Cloud Services
5) Dropbox
6) Oracle Clouds

7) Adobe Creative Cloud

AWS (Amazon Web Services)

AWS is Amazon's cloud web hosting platform which offers fast, flexible, reliable and cost-effective solutions. It is one of the top cloud service providers which offers a service in the form of building block which can be used to create and deploy any kind of application in the cloud. It is the most popular as it was the first to enter the cloud computing space.

Features:

- Easy sign-up process
- Fast Deployments
- Allows easy management of add or remove capacity
- Access to effectively limitless capacity
- Centralized Billing and management
- It is one of the cloud companies that offers Hybrid Capabilities and per hour billing.

Companies using AWS

- Instagram
- Pinterest
- Netflix
- Dropbox

Applications of AWS services

- Amazon Web services are widely used for various computing purposes like:
- Web site hosting
- Application hosting/SaaS hosting
- Media Sharing (Image/ Video)
- Mobile and Social Applications
- Content delivery and Media Distribution
- Storage, backup, and disaster recovery
- Development and test environments
- Academic Computing
- Search Engines
- Social Networking

Advantages of AWS

- Following are the pros of using AWS services:
- AWS allows organizations to use the already familiar programming models, operating systems, databases, and architectures.
- It is a cost-effective service that allows you to pay only for what you use, without any up-front or long-term
- commitments.
- You will not require to spend money on running and maintaining data centers.
- Offers fast deployments
- You can easily add or remove capacity.
- You are allowed cloud access quickly with limitless capacity.
- Total Cost of Ownership is very low compared to any
- private/dedicated servers.
- Offers Centralized Billing and management
- Offers Hybrid Capabilities

- Allows you to deploy your application in multiple regions around the world with just a few clicks.

Disadvantages of AWS

- If you need more immediate or intensive assistance, you'll have to opt for paid support packages.
- Amazon Web Services may have some common cloud computing issues when you move to a cloud. For example, downtime, limited control, and backup protection.
- AWS sets default limits on resources which differ from region to region.
- These resources consist of images, volumes, and snapshots.
- Hardware-level changes happen to your application which may not offer the best performance and usage of your applications.

AWS Services Here are some of AWS's essential offerings:

1**. Amazon S3**
This tool is used for internet back up, and it's the cheapest storage option in the object-storage category. The best part: you can retrieve stored data from almost anywhere whenever you need it.

2**. AWS Data Transfer Products** As the name suggests, these are migration, data collection, and data transfer products that help you collect data seamlessly. They also enable you to monitor and analyze data in real-time.

3. **Amazon EC2 (Elastic Compute Cloud)**
EC2 is a virtual machine in the cloud on which you have OS level control. You can run this cloud server whenever you want.

4. **Amazon SNS (Simple Notification Services)**
This is a notification tool that delivers messages to a large number of subscribers through email or SMS. You can send alarms, service notifications, and other messages intended to call attention to important information.

5. **Amazon KMS (Key Management System)**
This is a security tool that uses 256-bit encryption for your data. It also safeguards it from hackers and cyber attacks.

6. **Amazon Lambda**
This service runs your code depending on specific events and manages the dependent resources. You need neither managing nor provisioning servers, and how much you pay depends on how long it takes to execute your code. It saves a lot of money compared with services that charge hourly rates.

Google Cloud Platform

Google Cloud is a set of solution and products which includes GCP&G suite. It is one of the top cloud service providers which helps you to solve all kind of business challenges with ease.

Google Cloud Services

- Compute Services
- Storage Services
- Networking
- Big Data Services
- Security and Identity Management
- Management Tools
- Cloud AI
- IoT

Features:

- It is one of the cloud companies that allows you to scale with open, flexible technology
- Solve issues with accessible AI & data analytics

- Eliminate the need for installing costly servers
- Allows you to transform your business with a full suite of cloud-based services.

Services:

- Google Compute Engine, which is an infrastructure-as-a-service (IaaS) offering that provides users with virtual machine instances for workload hosting.
- Google App Engine, which is a platform-as-a-service (PaaS) offering that gives software developers access to Google's scalable hosting. Developers can also use a software developer kit (SDK) to develop software products that run on App Engine.
- Google Cloud Storage, which is a cloud storage platform designed to store large, unstructured data sets. Google also offers database storage options, including Cloud Datastore or NoSQL nonrelational storage, Cloud SQL for MySQL fully relational storage and Google's native Cloud Bigtable database.
- Google Container Engine, which is a management and orchestration system for Docker containers that runs within Google's public cloud. Google Container Engine is based on the Google Kubernetes container orchestration engine.

Services Provided by Cloud Providers

Name of Company	IaaS	Paas	SaaS
AWS	Amazon EC2	Amazon Web Services	Amazon Web Services
Microsoft	Microsoft Private Cloud	Microsoft Azure	Microsoft Office 365
Google	–	Google App Engine (Python, Java and many)	Google Applications
IBM	Smart Cloud Enterprise	Smart Cloud Application Services	SaaS Products