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Unit-V
CLOUD COMPUTING

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UNIT – V
CLOUD COMPUTING

Cloud

The term Cloud refers to a Network or Internet. In other words, we can say that Cloud is something, which is present at remote location. Cloud can provide services over network, i.e., on public networks or on private networks, i.e., WAN, LAN or VPN. Applications such as e-mail, web conferencing, customer relationship management (CRM), all run in cloud.

Cloud Computing

Cloud computing is the delivery of different services through the Internet. These resources include tools and applications like data storage, servers, databases, networking and software. Rather than keeping files on a proprietary hard drive or local storage device, cloud-based storage makes it possible to save them to a remote database. As long as an electronic device has access to the web, it has access to the data and the software programs to run it.

Cloud computing is a popular option for people and businesses for a number of reasons including cost savings, increased productivity, speed and efficiency, performance, and security.

Definition of Cloud Computing

The cloud is a large group of interconnected computers. These computers can be personal computers or network servers; they can be public or private. Cloud computing is a technology that uses the internet and central remote servers to maintain data and applications.

Eg: Yahoo email or Gmail etc.

BASIC CONCEPTS (OVERVIEW)

There are certain services and models working behind the scene making the cloud computing feasible and accessible to end users. Following are the working models for cloud computing:

- Deployment Models
- Service Models

Deployment Models

Deployment models define the type of access to the cloud, i.e., Cloud can have any of the four types of access: Public, Private, Hybrid and Community.
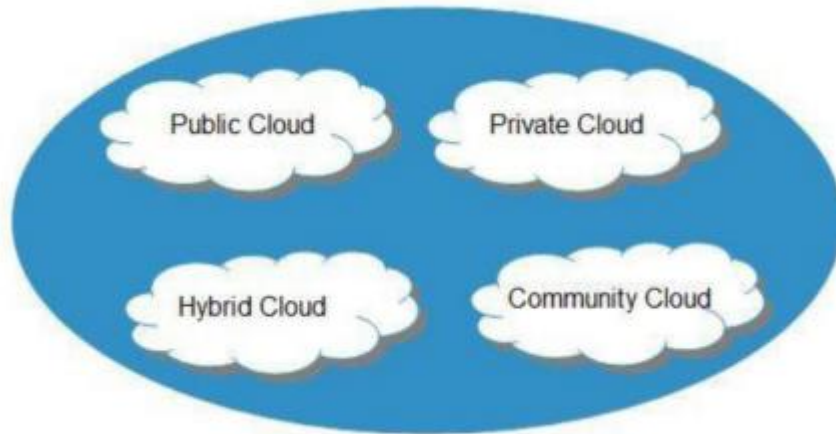
Public Cloud

The Public Cloud allows systems and services to be easily accessible to the general public. Public cloud may be less secure because of its openness, e.g., e-mail.

Private Cloud

The Private Cloud allows systems and services to be accessible within an organization. It offers increased security because of its private nature.

Community Cloud

The Community Cloud allows systems and services to be accessible by group of organizations.

Hybrid Cloud

The Hybrid Cloud is mixture of public and private cloud. However, the critical activities are performed using private cloud while the non-critical activities are performed using public cloud.

Service Models

Service Models are the reference models on which the Cloud Computing is based. These can be categorized into three basic service models as listed below:

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

There are many other service models all of which can take the form like XaaS, i.e., Anything as a Service. This can be Network as a Service, Business as a Service, Identity as a Service, Database as a Service or Strategy as a Service. The Infrastructure as a Service (IaaS) is

the most basic level of service. Each of the service models make use of the underlying service model, i.e., each inherits the security and management mechanism from the underlying model, as shown in the following diagram:
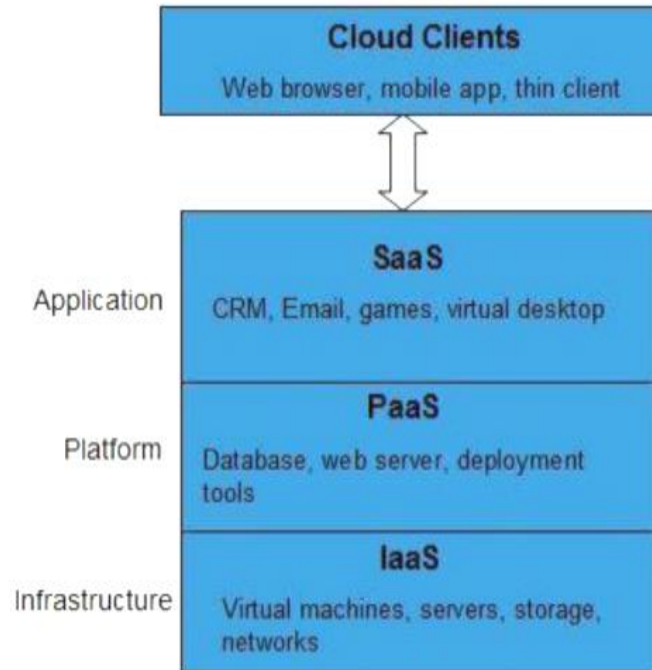
History of Cloud Computing (Origin)

The concept of Cloud Computing came into existence in 1950 with implementation of mainframe computers, accessible via thin/static clients. Since then, cloud computing has been evolved from static clients to dynamic ones from software to services. The following diagram explains the evolution of cloud computing:
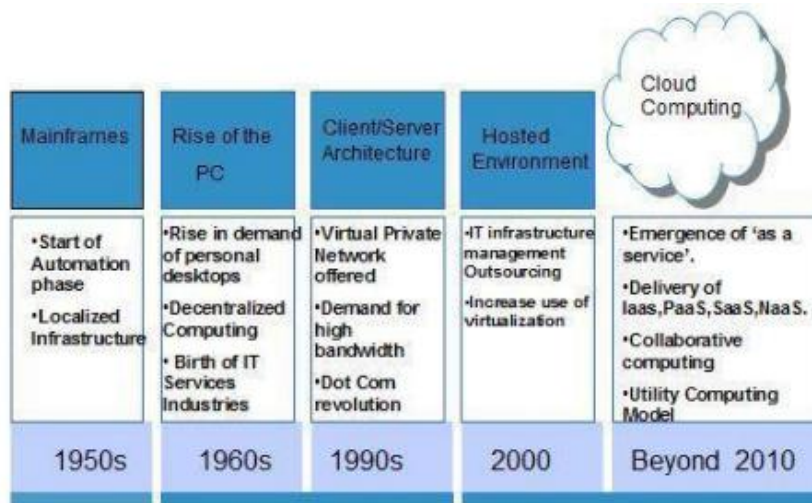
In 1999, Salesforce.com started delivering of applications to users using a simple website. The applications were delivered to enterprises over the Internet, and this way the dream of computing sold as utility were true.

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. Of course, all the big players are present in the cloud computing evolution, some were earlier, some were later. In 2009, Microsoft launched Windows Azure, and companies like Oracle and HP have all joined the game. This proves that today, cloud computing has become mainstream.

Advantages of Cloud Computing

Cloud Computing has numerous advantages. Some of them are listed below:

- One can access applications as utilities, over the Internet.
- Manipulate and configure the application online at any time.
- It does not require to install a specific piece of software to access or manipulate cloud application.
- Cloud Computing offers online development and deployment tools, programming runtime environment through Platform as a Service model.
- Cloud resources are available over the network in a manner that provides platform independent access to any type of clients.
- Cloud Computing offers on-demand self-service. The resources can be used without interaction with cloud service provider.
- Cloud Computing is highly cost effective because it operates at higher efficiencies with greater utilization. It just requires an Internet connection.
- Cloud Computing offers load balancing that makes it more reliable.

1) Internet Connectivity

As you know, in cloud computing, every data (image, audio, video, etc.) is stored on the cloud, and we access these data through the cloud by using the internet connection. If you do not have good internet connectivity, you cannot access these data. However, we have no any other way to access data from the cloud.

2) Vendor lock-in

Vendor lock-in is the biggest disadvantage of cloud computing. Organizations may face problems when transferring their services from one vendor to another. As different vendors provide different platforms, that can cause difficulty moving from one cloud to another.

3) Limited Control

As we know, cloud infrastructure is completely owned, managed, and monitored by the service provider, so the cloud users have less control over the function and execution of services within a cloud infrastructure.

4) Security

Although cloud service providers implement the best security standards to store important information. But, before adopting cloud technology, you should be aware that you will be sending all your organization's sensitive information to a third party, i.e., a cloud computing service provider. While sending the data on the cloud, there may be a chance that your organization's information is hacked by Hackers.

CLOUD COMPUTING REFERENCE MODEL (COMPONENTS)

The NIST cloud computing reference architecture Fig 1 defines five major actors:

- Cloud consumer
- Cloud provider
- Cloud carrier
- Cloud auditor and
- Cloud broker.

Each actor is an entity (a person or an organization) that participates in a transaction or process and/or performs tasks in cloud computing.
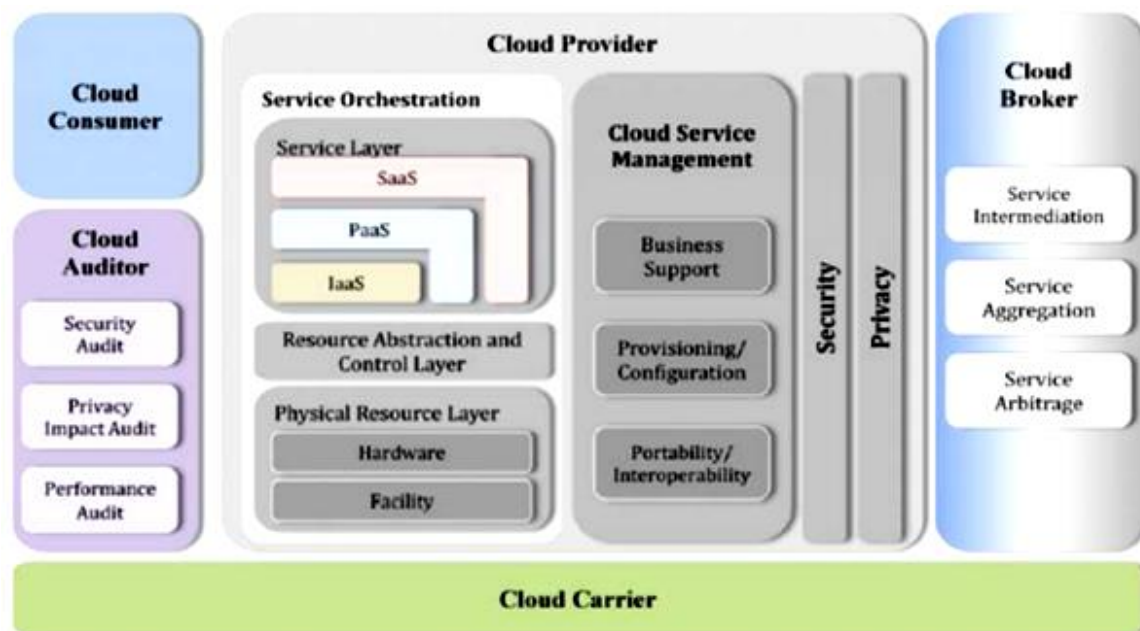
Actors in Cloud Computing

Sl.No.	Actor	Definitions
1	Cloud Consumer	A person or organization that maintains a business relationship with, and uses service from, Cloud Providers.
2	Cloud Provider	A person, organization, or entity responsible for making a service available to interested parties.
3	Cloud Auditor	A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
4	Cloud Broker	An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.
5	Cloud Carrier	An intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

Examples of Cloud Computing

► Examples of Cloud Storage

Ex: Dropbox, Gmail, Facebook

Right now, Dropbox is the clear leader in streamlined cloud storage allowing users to access files on any device through its application or website with up to 1 terabyte of free storage.

► Examples of Marketing Cloud Platforms

Ex: Hubspot, Adobe Marketing Cloud

A marketing cloud is an end-to-end digital marketing platform for clients to manage contacts and target leads.

► Examples of Cloud Computing in Education

Ex: SlideRocket, Ratatype, Amazon Web Services

Education is increasingly adopting advanced technology because students already are. So, to modernize classrooms, educators have introduced e-learning software like Slide Rocket.

► Examples of Cloud Computing in Healthcare

Ex: ClearDATA, Dell's Secure Healthcare Cloud.

Cloud computing lets nurses, physicians, and administrators share information quickly from anywhere.

► Examples of Cloud Computing for Government

Uses: IT consolidation, shared services, citizen services. TheU.S. government and military were early adopters of cloud computing.

CHARACTERISTICS OF CLOUD COMPUTING

There are basically 5 essential characteristics of Cloud Computing.

1. On-demand self-services:

The Cloud computing services does not require any human administrators, user themselves are able to provision, monitor and manage computing resources as needed.

2. Broad network access:

The Computing services are generally provided over standard networks and heterogeneous devices.

3. Rapid elasticity:

The Computing services should have IT resources that are able to scale out and in quickly and on as needed basis. Whenever the user require services it is provided to him and it is scale out as soon as its requirement gets over.

4. Resource pooling:

The IT resource (e.g., networks, servers, storage, applications, and services) present are shared across multiple applications and occupant in an uncommitted manner. Multiple clients are provided service from a same physical resource.

5. Measured service:

The resource utilization is tracked for each application and occupant, it will provide both the user and the resource provider with an account of what has been used. This is done for various reasons like monitoring billing and effective use of resource.

Characteristics of Cloud Computing Model

There are various Cloud Computing models based on the business requirement. Here is a list of different Cloud Computing models and their characteristics:

Characteristics of Cloud Computing model – PaaS

Some of the characteristics of PaaS in Cloud Computing are:

- PaaS provides a web-based development environment. It enables the developer to construct a database and change the application code using either an API or point-and- click tools.
- PaaS integrates scalability, security, and web service gateways.
- PaaS includes tools for creating a workflow, approval procedures, and business rules.
- PaaS can be seamlessly interfaced with other apps on the same platform.
- PaaS also includes web service interfaces that allow us to link apps not hosted on the platform.

Characteristics of Cloud Computing model – SaaS

Some of the characteristics of the Software as a service model are:

- SaaS enables the software available over the Internet.
- The vendor maintains the software programs.
- The software license can be subscription or utilization-based. It is also billed on a scheduled basis.
- Software as a service app does not require end-user maintenance.
- They are accessible upon request.
- They are upgraded and updated automatically.

Characteristics of Cloud Computing model – IaaS

Some of the characteristics of IaaS in Cloud Computing are:

- Virtual systems with pre-installed software.
- Virtual systems have pre-installed operating systems such as Windows, Linux, and Solaris.
- Request resource availability.
- Allows you to keep copies of specific data in several locations.
- The computer resources can be simply adjusted.

Use of Cloud Computing

To summarize, these characteristics of cloud computing offer the following benefits:

- With cloud computing, purchasing hardware and software is significantly cheaper.

- A good internet connection is required to access all of the information you need at any time and from any location.
- As demand increases, you can easily increase the capacity of this system. The services can be scaled and customized to meet the needs of individual users.
- Cloud service providers spend a lot of money on security to ensure that their customers receive high-quality services.
- Reliable storage can be found in the cloud. The process of backing up and restoring data is simple, inexpensive, and fast.
- Enterprise users can easily access services and applications without worrying about the underlying cost of infrastructures, making it more cost- and time-effective. This gives a boost to the firm's productivity. Cloud Computing vs. Traditional IT Infrastructure - Difference

- **Lowered Costs:** In cloud computing services, only what is used is paid. Further, decreased downtimes mean improved workplaces and augmented profits in the longer run. In conventional IT infrastructures, it is needed to purchase equipment and additional servers upfront for adapting to future business growth, so one ends up paying more for resources that even aren't used. Also, physical servers' value decreases gradually, so ROI is too low with traditional systems.

- **Automation:** Cloud hosting is done outside the premises and managed by cloud providers, who take care of all aspects, including the required hardware, thus ensuring that all security measures are well in place, and keep the things running smoothly. Conventional data centers, on the other hand, need massive amounts of in-house administration that could be costly and very much time-consuming for businesses. Trained staff is required for server monitoring and hardware maintenance, and a lot of effort goes into software installations, upgrades, configuration issues, and threat-protection.

- **Flexibility:** Cloud computing models provide increased flexibility as compared to conventional IT models. Companies can have complete control for installing any software whenever needed, which gives them better flexibility for businesses to grow.

- **Scalability:** Cloud virtual spaces have unlimited storage capacity and more & better server resources. Cloud servers usually can scale up/down as per the levels of website

traffic. With conventional IT models, only those resources are used, which are already available. If any business runs out of storage capacity, the sole solution remaining is to buy another server. For hiring more employees, additional software licenses have to be paid for, and to have them uploaded manually on office hardware can be a costly affair, especially for growing businesses.

Cloud Computing Vs Traditional IT Infrastructure

In cloud computing, data is saved externally, which seems less secure. Also, with free access to information by anyone anywhere, wherever the net connection is available, again causes data leakage threats. With traditional models, on the other hand, business owners are only responsible for the data protection of their organizational data. Still, that's not scalable and cost-efficient.

Cloud Computing	VS	Traditional IT
Shared	**Consumption**	Dedicated
Sell service	**Ease of Use**	Traditional hardware procurement
Scale on-demand	**Scalability**	New services added manually
Automated recovery due to integration? interoperable	**Availability**	Manual repair of system failure
Minutes	**Provisioning**	Months
Pay per use	**Cost**	Incremental CapEx purchases

ROOTS OF CLOUD COMPUTING

The roots of cloud computing are sub-divided into four types. They are,

- Internet Technologies
- Hardware
- System Management
- Distributed Computing

Internet Technologies in Cloud Computing

      Virtualization and Service-Oriented Architecture : Virtualization is the process of deploying virtual resources in cloud infrastructures such as servers, storage management, and desktop. To reduce the cost and time effort of cloud providers this virtualization concept is introduced. Virtualization is subdivided into various types. The below-mentioned picture describes the various types of virtualization used in cloud computing.

      Desktop Virtualization : Desktop Virtualization is the concept of users accessing their desktops virtually from any location. For the end-user environment, this desktop virtualization is created. The types of desktop virtualization are as follows,

      Virtual desktop Infrastructure-The actions are done in the central server which provides the virtual desktop service to the end-user. Remote desktop Services-Users are allowed to work based on windows applications remotely

      Application Virtualization : In application virtualization, the users are all allowed to use the application in the system rather than one which is installed. The OS and system software are installed on many computers.

Network Virtualization: The combination of both hardware and software operations is called Network Virtualization. It establishes a connection between the application and the software system.

Storage Virtualization: The storage virtualization array consists of multiple arrays which are appeared to be single virtualization. It can be either called a disk array or a storage array.

Server Virtualization: Partitioning the single server into multiple servers which can run on their independent operating system.

Service-Oriented Architecture (SOA) :As the business grows, there is a large number of implementation of software and hardware requirements, which is difficult to manage. Hence SOA helps to maintain and implement the architecture.

Grid Computing: To manage and handle a large set of data, the networked computers are connected to perform the operations. The group of computers joins as a cluster to simplify the task.

Utility Computing : As the name itself denotes, the providers provide the computing service based on the user's demand. It is based on the process of pay peruse.

Platform As A Service (PAAS): As the name itself indicates "platform" means it gives a complete technical platform to the customer such as hardware, software, and infrastructure for developing and deploying the application. The advantage of PAAS is, that it supplies networking, storage, server, operating system (OS), etc., a complete cloud platform to the user for developing and running their application without worrying about building and maintaining the cloud infrastructure required to develop and launch the app.

Infrastructure as a service (IAAS): It is purely an infrastructure-based cloud computing service that provides complete infrastructure like supporting web applications, and services based on user facility. As it is based storage and infrastructure.

The customer has to use this on by pay-as-you-go basis based on their demand. It reduces the cost of buying and managing physical servers and data infrastructures. increases the scale and performance of IT workloads and reduces the expenditure on buying external hardware tools. Examples of IAAS are Amazon Web Services, Google compute engine (GCE), Green Cloud Technologies, and Microsoft Azure.

Software as a Service (SAAS) : SAAS enables the end-user to use cloud-based applications utilizing the web. It is defined as "On- Demand Software "hosted by the cloud service provider. The users are allowed to subscribe to those cloud-based applications than purchasing. The users were given login credentials to use those applications which are running on cloud servers. One of the simple and easiest examples is Gmail.

Hardware : The hardware components of cloud computing include,

- Storage array
- Switches
- Router
- Firewall
- Backup devices
- Servers
- Load balancers

System Management : Cloud management consists of public, private, and hybrid clouds. Cloud computing performs the overall control and work of the system.

Public cloud: The public cloud is common to everyone and is easily accessible by anyone. It is provided over the internet to general people or major industry groups. Simple examples are Gmail and Google drive.

Private cloud: The difference between public and private is, that the latter ensures the privacy and security of the data through firewalls and internet hosting. If large IT organizations and business groups are looking for secure cloud options, the best option is the Private cloud. Examples of private clouds are Amazon Web Services, IBM, VMware, and Microsoft azure.

Multi-cloud: The name itself indicates partial meaning that the organization uses one or more cloud services such as public and private cloud or both public and private cloud. Examples of multi-cloud are Amazon Web Services (AWS), Google Cloud Platform (GCP), and IBM.

Hybrid cloud: The difference between multi and hybrid cloud is that the latter combines two or more different types of the cloud while multi-clouds combines different clouds of the same type. Examples: Include Azure Stack, Azure arc, and Google antos.

Distributed Computing : Distributed Computing is the connection of one or more several computers which are connected to form a network to share information. A wide number of computers are connected to a single network. Examples: Include the Internet and Gmail.