UNIT-1
CLOUD COMPUTING OVERVIEW

I) Introduction to Cloud computing:

Cloud Computing provides us means of accessing the applications as utilities over the Internet. It allows us to create, configure, and customize the applications online. The idea of cloud computing is based on a very fundamental principal of reusability of IT capabilities.

i) Why Cloud Computing:

Actually, Small as well as some large IT companies follows the traditional methods to provide the IT infrastructure. That mean 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.

i) What is 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 public and private networks, i.e., WAN, LAN or VPN.

Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.

What is Cloud Computing?

Cloud Computing refers to **manipulating, configuring,** and **accessing** the hardware and software resources remotely. It offers online data storage, infrastructure, and application. Cloud computing means on demand delivery of IT resources via the internet with pay-as-you-go pricing. It provides a solution of IT infrastructure in low cost.

Cloud Computing is a computing paradigm, where a large pool of systems is connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly.

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Cloud computing offers **platform independency,** as the software is not required to be installed locally on the PC.
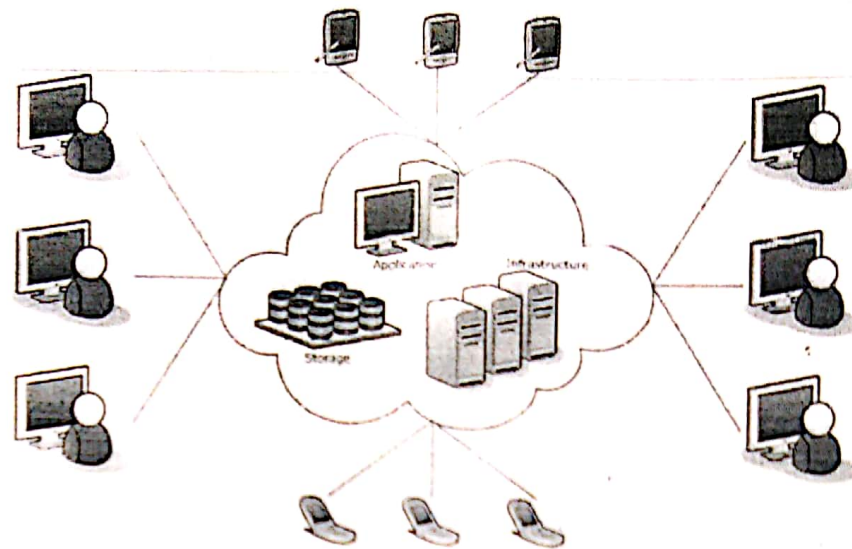
II) Origin or History and Evaluation of Cloud Computing:

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.

In 1990, the giant connecting concept - Internet, finally got enough computers attached to it and the connection of those machines together create a massive, interconnected shared pool of storage that won't be possible by a single organization. There comes the concept of "grid". The term 'grid' has a misinterpretation as a synonym for 'cloud computing' as both of the technology is formed from a lot of computers connected. 'Grid Computing' requires the usage of application programs to divide one large system processing to several thousands of machines. But there lies the disadvantage; that if a single part of a software node fails the processing or working, other pieces of that software nodes may also fail to process.

On the basis of above computing, there was emerged of cloud computing concepts that later implemented. The real cloud phase started in the 1999. In this phase internet as the mechanism to provide **Application as Service.**

On the first milestone of cloud technology, Salesforce.com engraved its name in 1999. It pioneered the technique of delivering enterprise application via a simple website. They provided both specialist & mainstream software firms to bring up used over the internet.

The next development was in 2002 by Amazon's Web Service (AWS). They provided cloud-oriented services including storage, computing power & human intelligence via Amazon Mechanical Turk. Then in 2006, Amazon launches their EC2 (Elastic Compute Cloud) - a commercial web service that let small organizations and sole proprietors to rent computers on which they run their computer applications. EC2/S3 became the 1ˢᵗ accessible cloud technology infrastructure service.

In 2009, Google Apps also started to provide cloud computing enterprise applications.

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.

**III) Cloud components:

Cloud computing solution is made up of several elements: clients, the datacenter, and distributed servers. As shown in Figure these components make up the three parts of a cloud computing solution.
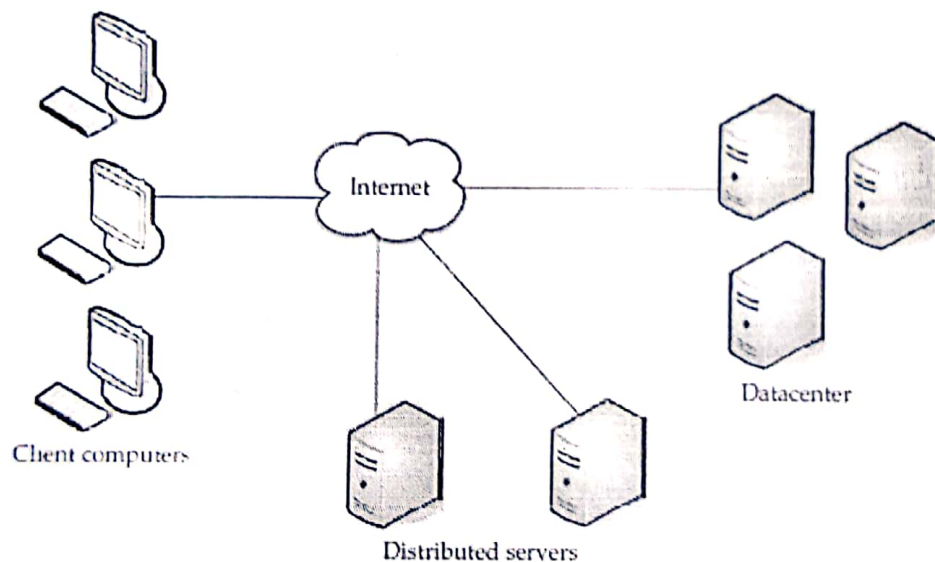
i) **Clients:** clients are the devices that the end users interact with to manage their information on the cloud. Clients generally fall into three categories:

- Mobile: Mobile devices include PDAs or smartphones, like a Blackberry, Windows Mobile Smartphone, or an iPhone.

- Thin: Clients are computers that do not have internal hard drives, but rather let the server does all the work, but then displays the information.

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- **Thick:** This type of client is a regular computer, using a web browser like Firefox or Internet Explorer to connect to the cloud.

  Thin clients are becoming an increasingly popular solution, because of their price and effect on the environment. Some benefits to using thin clients include
  - **Lower hardware costs:** Thin clients are cheaper than thick clients because they do not contain as much hardware.
  - **Lower IT costs:** Thin clients are managed at the server and there are fewer points of failure.
  - **Security:** Since the processing takes place on the server and there is no hard drive, there's less chance of malware invading the device. Also, since thin clients don't work without a server, there's less chance of them being physically stolen.
  - **Data security :** Since data is stored on the server, there's less chance for data to be lost if the client computer crashes or is stolen.
  - **Less power consumption :** Thin clients consume less power than thick clients. This means you'll pay less to power them, and you'll also pay less to air-condition the office.
  - **Ease of repair or replacement** If a thin client dies, it's easy to replace. The box is simply swapped out and the user's desktop returns exactly as it were before the failure.
  - **Less noise :** without a spinning hard drive, less heat is generated and quieter fans can be used on the thin client.

ii) **Datacenter:** The *datacenter* is the collection of servers where the application to which you subscribe is housed. It could be a large room in the basement of your building or room full servers on the other side of the world that you access via the Internet. A growing trend in the IT world is virtualizing servers. That is, software can be installed allowing multiple instances of virtual servers to be used. In this way, you can have half a dozen virtual servers running on one physical server.

iii) *Distributed Servers:* But the servers don't all have to be housed in the same location. Often, servers are in geographically disparate locations. But to you, the cloud subscriber, these servers act as if they're humming away right next to each other. This gives the service provider more flexibility in options and security. For instance, Amazon has their cloud solution in servers all over the world. If something were to happen at one site, causing a failure, the service would still be accessed through another site.

IV) Advantages and Disadvantages of Cloud Computing:

Advantages or Benefits:

1) **Easy implementation:** Cloud hosting allows business to retain the same applications and business processes without having to deal with the backend technicalities. Readily manageable by the Internet, a cloud infrastructure can be accessed by enterprises easily and quickly.

2. **Accessibility.** Access your data anywhere, anytime. An Internet cloud infrastructure maximizes enterprise productivity and efficiency by ensuring your application is always accessible. This allows for easy collaboration and sharing among users in multiple locations.

3. **No hardware required.** Since everything will be hosted in the cloud, a physical storage center is no longer needed. However, a backup could be worth looking into in the event of a disaster that could leave your company's productivity stagnant.

4. **Cost per head.** Cloud Computing is highly cost effective because it operates at high efficiency with optimum utilization. It just requires an Internet connection.

5. **Flexibility for growth.** The cloud is easily scalable so companies can add or subtract resources based on their needs. As companies grow, their system will grow with them.

6. **Efficient recovery.** Cloud computing delivers faster and more accurate retrievals of applications and data. With less downtime, it is the most efficient recovery plan.

Disadvantages or limitations:

- **Security and Privacy:** It is the biggest concern about cloud computing. Since data management and infrastructure management in cloud is provided by third-party, it is always a risk to handover the sensitive information to cloud service providers. Although the cloud computing vendors ensure highly secured password protected accounts, any sign of security breach may result in loss of customers and businesses.

- **Lock In:** It is very difficult for the customers to switch from one Cloud Service Provider (CSP) to another. It results in dependency on a particular CSP for service.

- **Isolation Failure:** This risk involves the failure of isolation mechanism that separates storage, memory, and routing between the different tenants.

- **Management Interface Compromise:** In case of public cloud provider, the customer management interfaces are accessible through the Internet.

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- **Insecure or Incomplete Data Deletion:** It is possible that the data requested for deletion may not get deleted. It happens because either of the following reasons :
  - Extra copies of data are stored but are not available at the time of deletion.
  - Disk that stores data of multiple tenants is destroyed.
- **No longer in control.** When moving services to the cloud, you are handing over your data and information. For companies who have an in-house IT staff, they will be unable to handle issues on their own.

V) Cloud computing deployment & service models:

i) Deployment Models:

1) Public Cloud allows systems and services to be easily accessible to general public. The IT giants such as **Google, Amazon** and **Microsoft** offer cloud services via Internet.

Benefits:

There are many benefits of deploying cloud as public cloud model. The following diagram shows some of those benefits:

- **Cost Effective: Since** public cloud shares same resources with large number of customers it turns out inexpensive.
- **Reliability:** The public cloud employs large number of resources from different locations. If any of the resources fails, public cloud can employ another one.
- **Flexibility:** The public cloud can smoothly integrate with private cloud, which gives customers a flexible approach.
- **Location Independence:** Public cloud services are delivered through Internet, ensuring location independence.
- **Utility Style Costing:** Public cloud is also based on pay-per-use model and resources are accessible whenever customer needs them.
- **High Scalability:** Cloud resources are made available on demand from a pool of resources, i.e., they can be scaled up or down according the requirement.

Disadvantages

- **Low Security:** In public cloud model, data is hosted off-site and resources are shared publicly, therefore does not ensure higher level of security.
- **Less Customizable:** It is comparatively less customizable than private cloud.

2) **Private Cloud** allows systems and services to be accessible within an organization. The Private Cloud is operated only within a single organization. However, it may be managed internally by the organization itself or by third-party.

Advantages:

- **High Security and Privacy: Private** cloud operations are not available to general public and resources are shared from distinct pool of resources. Therefore, it ensures high security and privacy.
- **More Control:** The private cloud has more control on its resources and hardware than public cloud because it is accessed only within an organization.
- **Cost and Energy Efficiency:** The private cloud resources are not as cost effective as resources in public clouds but they offer more efficiency than public cloud resources.

Disadvantages:

- **Restricted Area of Operation:** The private cloud is only accessible locally and is very difficult to deploy globally.
- **High Priced: Purchasing** new hardware in order to fulfill the demand is a costly transaction.
- **Limited Scalability:** The private cloud can be scaled only within capacity of internal hosted resources.

3) **Hybrid Cloud** is a mixture of public and private cloud. Non-critical activities are performed using public cloud while the critical activities are performed using private cloud.

- **Scalability:** It offers features of both, the public cloud scalability and the private cloud scalability.
- **Flexibility:** It offers secure resources and scalable public resources.
- **Cost Efficiency: Public** clouds are more cost effective than private ones. Therefore, hybrid clouds can be cost saving.
- **Security:** The private cloud in hybrid cloud ensures higher degree of security.

Disadvantages:

- **Networking Issues: Networking** becomes complex due to presence of private and public cloud.
- **Security Compliance:** It is necessary to ensure that cloud services are compliant with security policies of the organization.
- **Infrastructure Dependency:** The hybrid cloud model is dependent on internal IT infrastructure; therefore it is necessary to ensure redundancy across data centers.

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ii) Service Models:
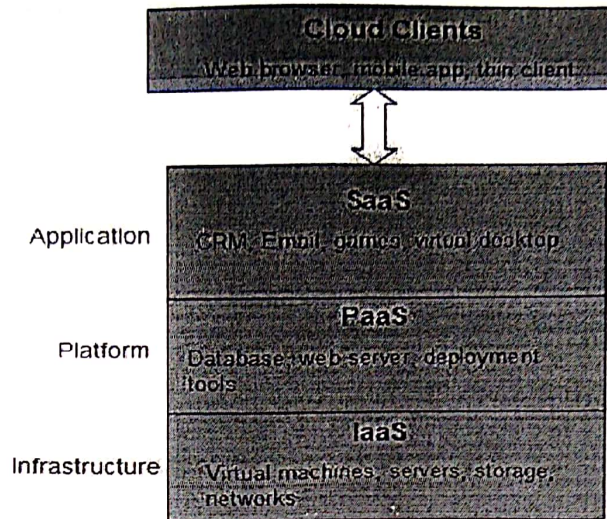
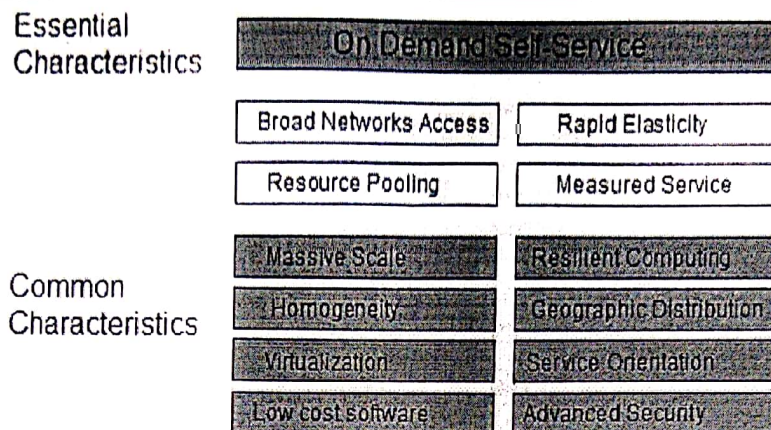1) **Application or Software as a Service (SaaS).** The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

2) **Platform as a Service (PaaS).** The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications.

3) **Infrastructure as a Service (IaaS).** The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

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VI) Characteristics of Cloud Computing:

The essential characteristics of the cloud computing model were defined by the National Institute of Standards and technology (NIST):

Essential Characteristics	On Demand Self-Service	
	Broad Networks Access	Rapid Elasticity
	Resource Pooling	Measured Service
Common Characteristics	Massive Scale	Resilient Computing
	Homogeneity	Geographic Distribution
	Virtualization	Service Orientation
	Low cost software	Advanced Security

1. **On-demand self-service:** On-demand self service refers to the service provided by cloud computing vendors that enables the provision of cloud resources on demand whenever they are required. In on-demand self service, the user accesses cloud services through an online control panel.

2. **Broad network access: Broad network access** refers to resources hosted in a private **cloud network** (operated within a company's firewall) that are available for **access** from a wide range of devices, such as tablets, PCs, and smartphones. These resources are also accessible from a wide range of locations that offer online **access**.

3. **Resource pooling:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state or datacenter). Examples of resources include storage, processing, memory and network bandwidth.

4. **Rapid elasticity:** Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward corresponding with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

5. **Measured service:** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of

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service (e.g., storage, processing, bandwidth and active user accounts). Resource usage can be monitored, controlled and reported, providing transparency for the provider and consumer.

VII) CLOUD COMPUTING TECHNOLOGIES:

There are certain technologies working behind the cloud computing platforms making cloud computing flexible, reliable, and usable. These technologies are listed below:

- Virtualization

- Service-Oriented Architecture (SOA)

- Grid Computing

- Utility Computing

1) Virtualization: **Virtualization** is a technique, which allows sharing single physical instance of an application or resource among multiple organizations or tenants (customers). It does this by assigning a logical name to a physical resource and providing a pointer to that physical resource when demanded.
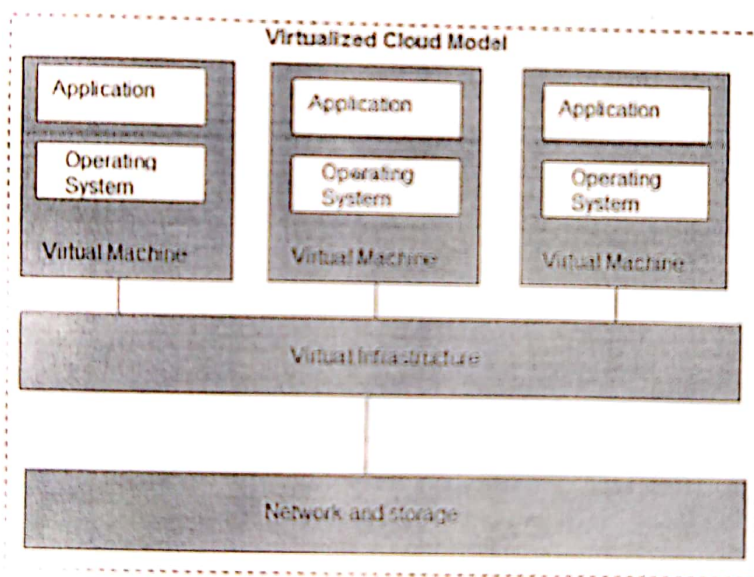

2) Service-Oriented Architecture (SOA): Service-Oriented Architecture helps to use applications as a service for other applications regardless the type of vendor, product or technology. Therefore, it is possible to exchange the data between applications of different vendors without additional programming or making changes to services.

The cloud computing service oriented architecture is shown in the diagram below:

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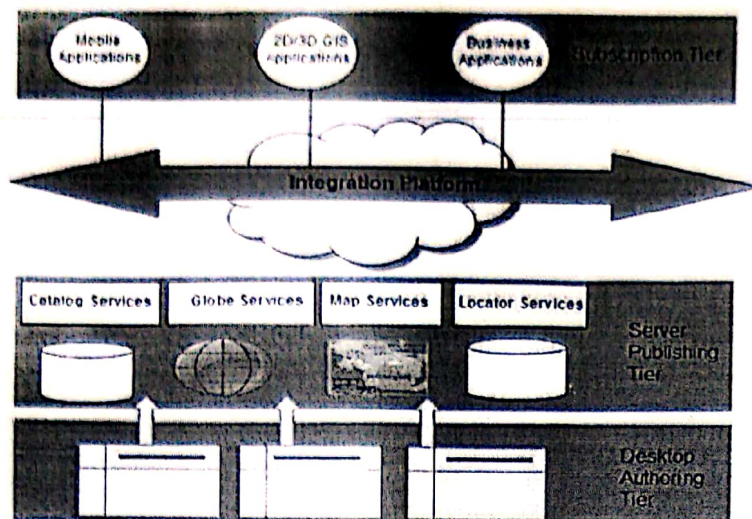
3. Grid Computing: Grid **Computing** refers to distributed computing, in which a group of computers from multiple locations are connected with each other to achieve a common objective. These computer resources are heterogeneous and geographically dispersed.

Grid Computing breaks complex task into smaller pieces, which are distributed to CPUs that reside within the grid.
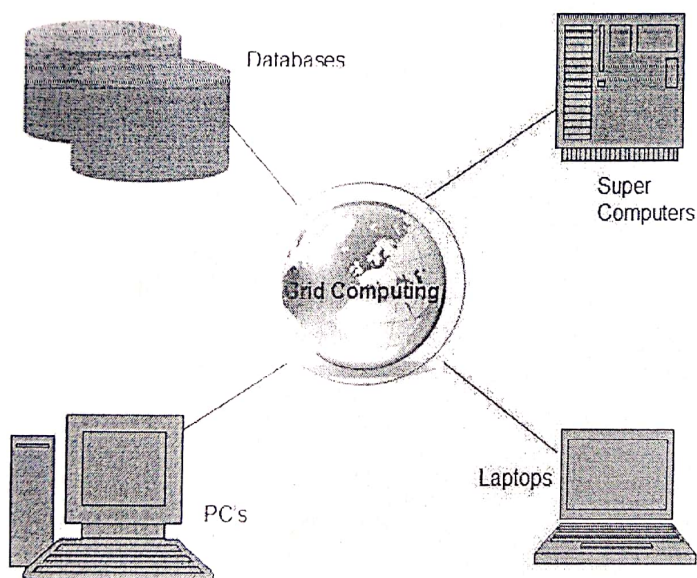
4) Utility Computing: Utility computing is based on **Pay-per-Use model.** It offers computational resources on demand as a metered service. Cloud computing, grid computing, and managed IT services are based on the concept of utility computing.