

UNIT - 2 Cloud Computing

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Cloud Computing

Definition:- Cloud Computing means Using the internet to Store and work with data instead of Keeping everything on your Computer. When you Save Something on your Computer, its only on that Computer. But with Cloud Computing, you can Save and Open your data from anywhere, as long as you're online. For example, if you Save a file in Google Drive, you can Open it from any device that has an internet Connection.

The "cloud" just means "the Internet". So, when we talk about the cloud, we mean we're using the internet to store or run things. The cloud is flexible, means it can grow bigger or smaller depending on what you need. Scalability means it can increase Space to fit more. Elasticity means it can quickly change size to match our needs.

NIST Definition of Cloud Computing

The official definition of cloud computing comes from the National Institute of Standards and Technology (NIST). It says that cloud computing is a way to easily access shared computer resources over the internet. These resources include things like networks, servers, storage, applications, and services. You can quickly use or stop using these resources with very little effort needed to manage it.

In simple terms, cloud computing means that companies can provide resources (like servers or storage) that are not physically on your computer but can be accessed from anywhere over the internet. You only pay for what you use, like how you pay for electricity based on how much you use.

Here are some key points from the NIST definition. (a) Motivation of cloud computing

① Resources are available from the cloud provider:-

This includes hardware like servers and storage, as well as software and applications. They are all provided over the internet by cloud provider.

② Pay-as-you-go:-

You pay only for the amount you use. If you need more resources, the provider can quickly add them, and if you need less, it adjusts down. This flexibility is called elasticity.

③ Minimal management on your side:-

you don't need to worry much about maintaining these resources since the cloud provider handles that. You only need to maintain your own devices that connect to the cloud.

This definition is widely accepted, even by Standards Organizations like ISO and IEEE.

History of Cloud Computing

⇒ The idea of cloud computing was introduced by Computer Scientist John McCarthy publicly in 1960's.

① 1960's:- The idea of cloud computing began with the concept of time-sharing. Mainframe computers were expensive, so organizations allowed multiple users to access a single computer's resources, sharing time and costs. This is seen as an early version of cloud computing.

② 1990's :- when the internet grew, companies like Salesforce began offering software that people could use online instead of installing it on their own computers. This was one of the first examples of using the "cloud".

③ 2000's - In 2006, Amazon launched Amazon web Services (AWS), which allowed businesses to rent virtual servers online instead of buying their own. This made cloud computing popular and affordable.

④ 2010's - Big companies like Microsoft and Google started offering cloud services. Many businesses began using the cloud to store data and run applications online.

⑤ 2020's :- Today, cloud computing is common and is used with new technologies like AI (Artificial Intelligence). Companies use the cloud to grow quickly and work from anywhere. Cloud computing helps businesses save money, work faster, and be flexible.

Advantages, Disadvantages, Limitations of Cloud Computing

Advantages:

- ① cheaper Computers. Since most apps run in the cloud, your computer doesn't need to be very powerful.
- ② Better performance. Cloud computers work faster because they don't have many programs running at once.

- ③ Lower Software Costs: Many cloud apps are free or cheaper than buying traditional software.
- ④ Automatic updates: Cloud apps always give you the latest version; no need to download or pay for updates.
- ⑤ Easy Document Sharing: You don't have to worry about your files working on other computers. Cloud tools support document sharing.
- ⑥ Lots of Storage: You get almost unlimited space to store files in the cloud.
- ⑦ Safer Data: If your computer crashes, your data is still safe in the cloud.
- ⑧ Access from anywhere: You can open your files from any device, wherever you are.
- ⑨ Always the latest Version: Your documents in the cloud are always up-to-date.
- ⑩ Better Teamwork: It's easier to share files and work together with others using the cloud.
- ⑪ Works on any device: Whether you're using a phone, tablet, or computer, you can always access your apps and files.

Disadvantages of cloud Computing

- ① Internet Dependency: You need a good internet connection to access cloud service. Without it, you can't use the cloud.
- ② Security and privacy: Your data is stored online, which can be risky. Hackers could try to access your information, and there might be privacy issues.
- ③ Downtime: If the cloud service goes down (like if the server has a problem), you won't be able to access your data or apps.
- ④ Limited Control: You don't have full control over the cloud infrastructure. It's managed by the cloud provider, so you can't make every decision about how it works.
- ⑤ Ongoing Costs: While cloud computing can be cheaper at first, the costs can add up over time, especially if you need a lot of storage or services.

Limitations of cloud Computing

- ① Storage limits: Even though cloud storage is large, it still has limits. If you use too much space, you may need to pay for more.
- ② Performance issues: Sometimes, cloud services can be slower if there's a lot of traffic or the cloud provider is having technical problems.

③ Compatibility: Not all applications work well in the cloud, so you might face issues with some older software or hardware.

④ Data Transfer Speed:

Uploading or downloading large amounts of data can be slow, depending on your internet speed and the cloud service provider.

Features of Cloud Computing

- ① On-Demand Service: You can use cloud services whenever you need them, just like switching on a light. No need to ask anyone.
Like paying for electricity based on your usage.
- ② Pay-As-you-Go: You only pay for what you use. If you use less, you pay less.
- ③ Scalability: It can grow or shrink as per your needs. If you need more storage, you can easily get it.
- ④ Accessibility: You can access your data or apps from anywhere in the world using the internet.
- ⑤ Security: Cloud providers protect your data with strong security measures.
- ⑥ Backup and Recovery: Your data is backed up automatically, and you can recover it if something goes wrong.
- ⑦ Resource Sharing: In cloud computing, many users use the same servers, storage, or software ~~by el.~~ provided by cloud provider.
- ⑧ High Speed: Cloud services are fast, and you can start using them within minutes.
- ⑨ Maintenance-Free: The cloud providers take care of all updates and maintenance, so you don't have to worry about it.
- ⑩ Nature-friendly: In cloud computing, multiple users share the same servers. Less electricity is used. It reduces the harmful effects like pollution.

Popular Cloud Applications in the Market

- ① Google Drive :- cloud storage service to store files, documents, photos and videos. Allows you to access your data from any device and share files.
- ② Dropbox :- Another cloud storage platform similar to Google Drive, mainly focused on file synchronization and sharing.
- ③ Microsoft OneDrive :- cloud storage and file sharing service, integrated with Microsoft office applications (Word, Excel etc...) to help store and collaborate on documents.
- ④ Amazon web Services (AWS) :- A set of tools and services for businesses to use cloud resources. Provides computing power, storage and tools that companies need to run applications without owning physical servers.
- ⑤ Salesforce :- helps companies manage relationships with customers. A tool that keeps track of sales, customer interactions and marketing, all in one place.

⑥ Slack:-

A messaging app for teams to communicate and share files. Teams can chat, share files and stay updated on projects.

⑦ Zoom:-

An app for online video meetings. Used for video calls, webinars, and team meetings, especially useful for remote work.

⑧ Office 365:-

Online versions of Microsoft Word, Excel and PowerPoint. Lets you use Microsoft Office tools online and share documents with others.

⑨ Adobe Creative Cloud:-

A set of creative tools like Photoshop for editing photos and videos. Lets designers and artists create and store their projects online.

⑩ Netflix:-

A video streaming service. Lets you watch movies and TV shows online anytime.

When Not to Use cloud Computing

There are situations where cloud Computing may not be the best choice.

Here are some examples

① Sensitive Data and Privacy Concerns

If your organization handles highly sensitive data (like personal health records, financial data, or government information) and privacy is top priority; storing that data in the cloud may not be safe unless the cloud provider meets strict security standards.

② Lack of Internet Access

If you are in an area with unreliable or slow internet, using cloud services can be problematic. Cloud services require a stable internet connection, and without it, won't be able to access your data or applications.

③ High Costs for Long-term Use

For small businesses or personal use, cloud services may seem cheaper initially, but overtime, the subscription fees can add up.

④ Compliance and Regulatory Requirements

Certain industries have strict regulations about where and how data is stored (such as healthcare, banking, or legal). If cloud providers don't comply with the required standards, it might not be good to use cloud for storing or processing sensitive data.

⑤ Limited Control over infrastructure.

Cloud computing typically means you don't own or control the infrastructure. If you want any software or hardware configurations, cloud providers cannot offer.

⑥ Performance Concerns (High Latency)

If your application requires high speed processing or low latency such as real-time gaming, scientific research, cloud computing might introduce delays or performance issues.

⑦ Vendor Lock-in

Cloud platforms may make it difficult to move your data or applications to another provider later. If you're concerned about being "locked in" to particular cloud vendor, it might be a reason to avoid using the cloud.

⑧ Small-Scale projects

If you are working on a small project like storing a few files or creating a simple application, using cloud services might be more than you need.

In these cases, you may want to consider alternatives like on-premises hardware or private clouds, or ensure that cloud providers meet specific security and performance needs.

Cloud EcoSystem

→ A cloud ecosystem is like a team working together to provide cloud services. This "team" includes parts like software, hardware, storage, and networks, as well as the people and companies involved in making everything work!

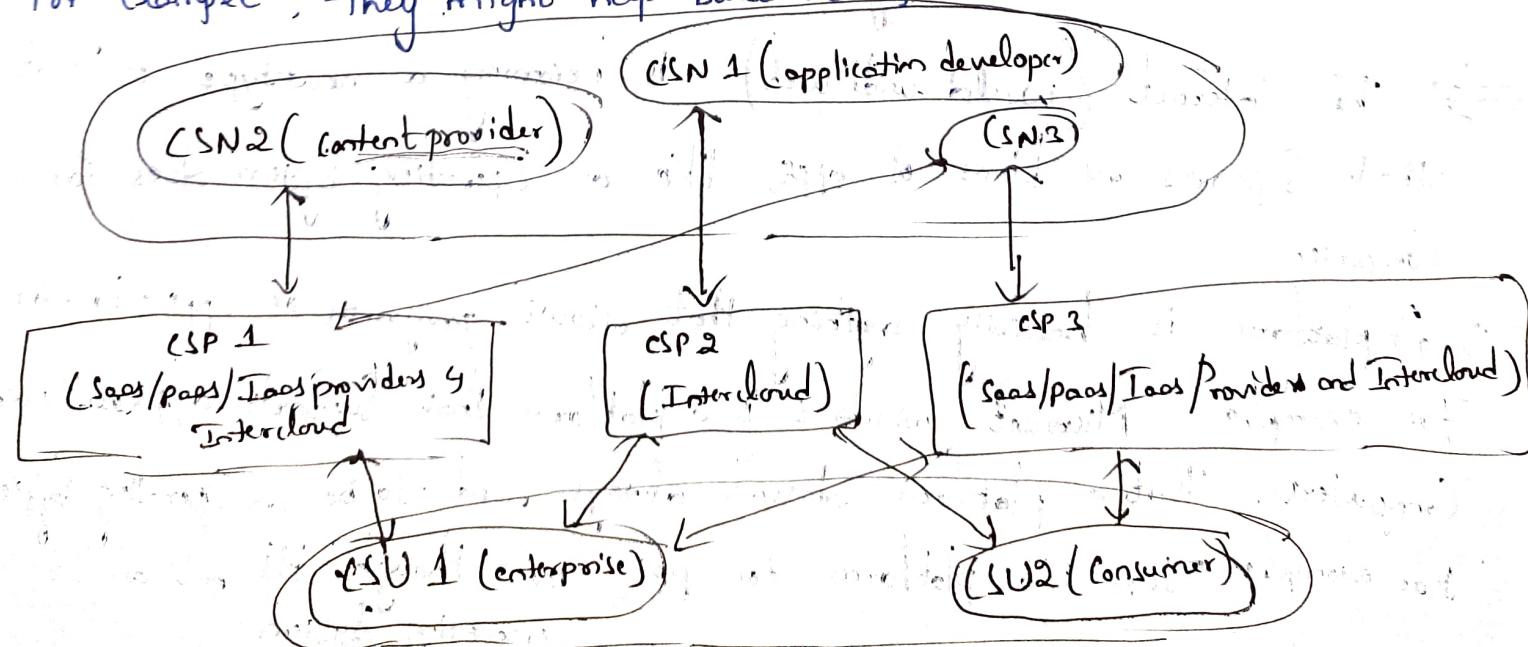
Here are the main players:-

① Cloud Service Users (CSUs) :- These are the people or organizations that use cloud services. Think of them as "customers" of the cloud. For example,

- A business using a cloud app to save files or store data.
- A person using a cloud service like Google Drive to store photos.

② Cloud Service providers (CSPs) :- These are companies that create and maintain the cloud services, like Amazon or Microsoft. They provide things like apps (SaaS), platforms for creating apps (PaaS), and the computer systems that make all this work (IaaS).

③ Cloud Service partners (CSNs) :- These are people or companies that help CSPs improve cloud services. For example, they might help build new features or add extra services.



Cloud Computing as a Service

⇒ One basic thing computers do is let us store and get back information, like photos, songs, or movies. Cloud Computing takes this a step further, letting us do the same but on the Internet.

For example, let us consider Flickr: website, example of cloud service

Access Anywhere: Flickr lets us store photos online, so we can see them anywhere, on any device. You could upload photos from your computer at home, then look at them on a laptop at work.

Easy Sharing: Instead of saving photos to a flash drive or CD to share, you can just share your Flickr link with friends or family.

Data Security: If we store our photos on Flickr, we have an online backup, while it's good to keep copies at home, it's easy to lose them. Flickr helps keep our images safe as an extra backup.

Cloud Computing as a Platform

⇒ The Internet (World Wide Web) is becoming a new type of "platform" that supports all kinds of apps, like an Operating System does for a computer.

⇒ A platform is basically anything that allows programs or apps to run.

For example, Microsoft Windows is a platform that supports apps on our computers. But a platform doesn't always need to be an Operating System.

For example, Java is a platform for apps, even though it's not an operating system.

→ Through cloud Computing, the internet is turning into a platform. This means that apps that used to only work on desktops (like Microsoft Word) now have versions online. Apps like Google Docs let us work from the Cloud just like on a Computer, so cloud Computing is now becoming a platform to support these web-based apps.

Virtual Machines

A Virtual Machine is ~~a part of~~ like having a "Computer inside a Computer". Special Software makes a Virtual machine by dividing the main Computer into Smaller "virtual" Computer.
Popular Softwares:- VMware, Oracle Virtual Box.

How it works:-

- ① Creates Copies: Cloud providers (like AWS, Azure) create VMs by dividing a Single physical Server (the main Computer) into multiple Smaller Virtual Servers.
- ② Separate and Independent: Each VM works independently. You can run different softwares on each Virtual machine without affecting others.
- ③ On Demand:- You only create and pay for VMs when you need them. When you're done, you can delete them. So you only pay for what you use.
- ④ Common in Clouds- VMs are popular in cloud Computing because they let people use powerful servers to run different programs without buying more hardware.

Multi-tenant cloud

A multi-tenant cloud is a type of cloud setup where many customers share the same cloud resource (like storage, servers, or software). Each customer (called a "tenant") has their own separate area within this shared space, so their data is safe and hidden from others.

Key points of Multi-Tenant Cloud:

Shared Environment: Multiple people or companies use the same software at the same time, but each tenant has their own separate look, settings and data.

Customization: Each tenant can change certain parts of the application to fit their needs, such as:

- ① User Interface: Each tenant can make the app look unique for their users.
- ② Business process: They can adjust the rules or workflows of the app to match their way of doing business.
- ③ Data Model: Tenants can add or remove fields in the app's database to suit their needs.
- ④ Access Control: Each tenant can decide who can access what in the app.

Benefits of Multi-Tenancy:

- ① Cost Savings: Since resources are shared, the provider can offer services at a lower cost to customers.

② Better Quality and User Satisfaction:

The provider can gather feedback and improve the service for everyone at once. This helps keep customers happy and using the service longer.

③ Improved Security:

Multi-tenant setups use strong security models to keep each tenant's data safe, even if others are using the same system.
⇒ Multi-tenant cloud technology lets different customers use shared cloud resources securely and at lower cost.

Principles of Cloud Computing

The principles sets by NIST (National Institute of Standards and Technology) helps us understand cloud computing:

- ① Five Key Features: These are the main features that make cloud computing what it is.
- ② Four Deployment Types: These describe how cloud services are provided and where they are hosted.
- ③ Three Service Models: These are the main type of cloud services you can get.

Five Key Features of Cloud Computing

- ① On-demand Self Service: You can setup or use resources (like servers or storage) on your own, without waiting for anyone to help you.
- ② Broad network access: You can access these resources over the internet from different devices (phones, laptop, etc..).
- ③ Elastic resource pooling: Cloud computing resources like servers, storage, and network bandwidth are shared and can be adjusted automatically.
- ④ Rapid elasticity: Resources can grow (scale up) or shrink (scale down) as needed, making it feel like resources are unlimited.
- ⑤ Measured Services: You're only charged for what you use, and usage can be tracked for clarity.

Four Deployment Models

Deployment models explain how cloud services are setup:-

- ① Private Cloud:
→ The cloud is dedicated to a single organization, meaning that only members of that organization can access it.

- ⇒ It can be hosted on-site (on the organization's own property) or off-site (managed by a third-party.)
 - ⇒ offers more control, privacy, and security, which is especially useful for organizations with sensitive data or strict regulations (like banks or health care organizations)
- Example: - A large company might set up a private cloud just for its employees to securely share files, use software, and store data.

- ② Public Cloud:
- ⇒ Open for anyone to use, like individuals, businesses, and other organizations.
 - ⇒ public clouds are managed by large companies, called cloud providers, (such as Amazon web services, Google cloud, Microsoft Azure).
 - ⇒ The resources are located in data centers owned by the providers, not on the user premises.
 - ⇒ this model is often cheaper and easier to setup because the provider manages everything, and users only pay for what they use.

Example: Anyone can sign up for ~~for~~ Google Drive or Microsoft OneDrive, which are public ~~for~~ cloud services for storing files.

- ③ Community Cloud:
- ⇒ A group of organizations with similar needs, concerns or interests.
 - ⇒ Community clouds are shared by organizations that have common goals or policies, such as government agencies or research institutions.
 - ⇒ It may be on one of the members' organizations premises or managed by a third-party provider.

⇒ Allows organizations to share resources and collaborate while keeping their data secure and meeting shared requirements, like common rules.

Example: Multiple government departments might use a community cloud to securely share information and applications specific to their work.

④ Hybrid cloud:

- Any organization that wants a flexible setup combining different types of clouds.
- ⇒ A hybrid cloud combines two or more of the above models (public, private, and community clouds). These clouds stay separate but can communicate with each other.
- ⇒ It's partly hosted on-premises and partly in public or private data centers.
- ⇒ Allows organizations to keep some resources private while still taking advantage of public cloud services when needed, like for extra storage or computing power.

Example: A company could use a private cloud to store sensitive information and a public cloud to run applications that don't need much security. If the private cloud runs out of capacity, the hybrid cloud setup can "burst" into the public cloud to handle the extra load.

Three Service Models

These are the main ways you can use cloud computing services.

① IaaS (Infrastructure as a Service) :-

Provides basic IT resources, like servers and storage.

② PaaS (Platform as a Service) :-

Provides a platform to build and run applications without managing the underlying infrastructure.

③ SaaS (Software as a Service) :-

Provides applications that you can use directly (like Google or Microsoft Office) over the internet.