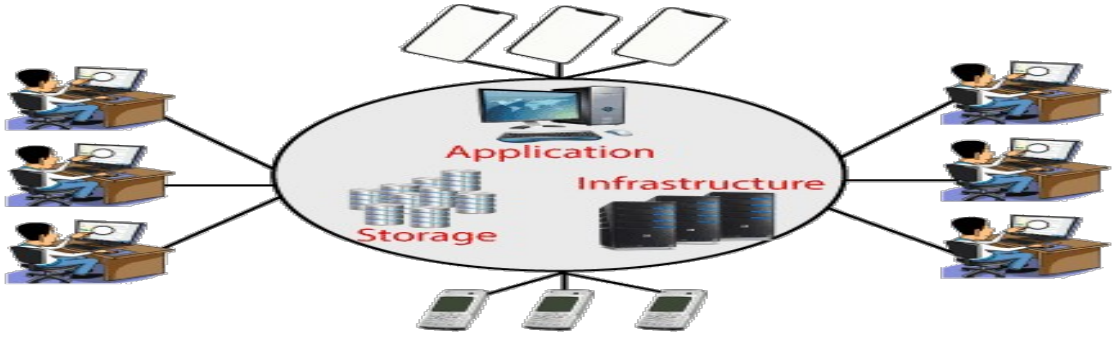
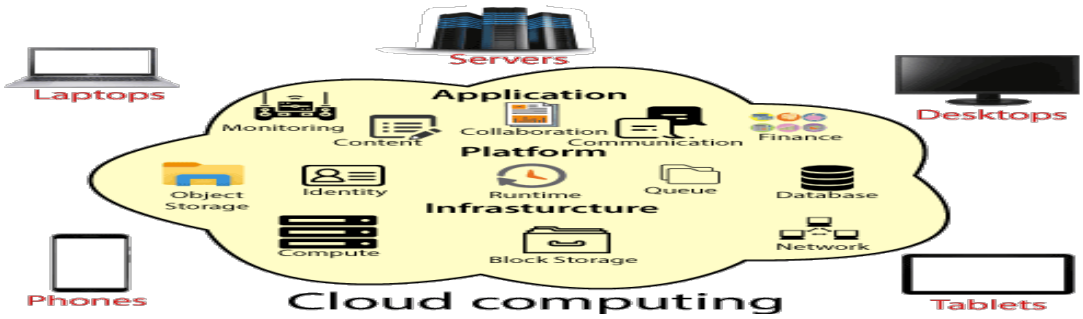
Unit -1

INTRODUCTION TO CLOUD COMPUTING

Cloud Computing is the delivery of computing services such as servers, storage, databases, networking, software, analytics, intelligence, and more, over the Cloud (Internet).



Cloud Computing provides an alternative to the on-premises datacentre. With an on-premises datacentre, we have to manage everything, such as purchasing and installing hardware, virtualization, installing the operating system, and any other required applications, setting up the network, configuring the firewall, and setting up storage for data. After doing all the set-up, we become responsible for maintaining it through its entire lifecycle.
But if we choose Cloud Computing, a cloud vendor is responsible for the hardware purchase and maintenance. They also provide a wide variety of software and platform as a service. We can take any required services on rent. The cloud computing services will be charged based on usage.



The cloud environment provides an easily accessible online portal that makes handy for the user to manage the compute, storage, network, and application resources. Some cloud service providers are in the following figure.

ADVANTAGES OF CLOUD COMPUTING

- **Cost:** It reduces the huge capital costs of buying hardware and software.
- **Speed:** Resources can be accessed in minutes, typically within a few clicks.
- **Scalability:** We can increase or decrease the requirement of resources according to the business requirements.
- **Productivity:** While using cloud computing, we put less operational effort. We do not need to apply patching, as well as no need to maintain hardware and software. So, in this way, the IT team can be more productive and focus on achieving business goals.
- **Reliability:** Backup and recovery of data are less expensive and very fast for business continuity.
- **Security:** Many cloud vendors offer a broad set of policies, technologies, and controls that strengthen our data security.

Types of Cloud Computing

- **Public Cloud:** The cloud resources that are owned and operated by a third-party cloud service provider are termed as public clouds. It delivers computing resources such as servers, software, and storage over the internet
- **Private Cloud:** The cloud computing resources that are exclusively used inside a single business or organization are termed as a private cloud. A private cloud may physically be located on the company's on-site datacentre or hosted by a third-party service provider.
- **Hybrid Cloud:** It is the combination of public and private clouds, which is bounded together by technology that allows data applications to be shared between them. Hybrid cloud provides flexibility and more deployment options to the business.

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.

Cloud Service Models

There are the following three types of cloud service models -

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)

Infrastructure as a Service (IaaS)

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

Characteristics of IaaS

There are the following characteristics of IaaS -

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

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

Platform as a Service (PaaS)

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

Characteristics of PaaS

There are the following characteristics of PaaS -

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

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

Software as a Service (SaaS)

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

Characteristics of SaaS

There are the following characteristics of SaaS -

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

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

Difference between IaaS, PaaS, and SaaS

The below table shows the difference between IaaS, PaaS, and SaaS -

IaaS	Paas	SaaS
It provides a virtual data center to store information and create platforms for app development, testing, and deployment.	It provides virtual platforms and tools to create, test, and deploy apps.	It provides web software and apps to complete business tasks.

It provides access to resources such as virtual machines, virtual storage, etc.	It provides runtime environments and deployment tools for applications.	It provides software as a service to the end-users.
It is used by network architects.	It is used by developers.	It is used by end users.
IaaS provides only Infrastructure.	PaaS provides Infrastructure+Platform.	SaaS provides Infrastructure+Platform +Software.

CLOUD SERVICES EXAMPLES

'CLOUD SERVICES ' REFERS TO THE RANGE OF SERVICES DELIVERED TO COMPANIES AND CUSTOMERS OVER THE INTERNET .

Instead of maintaining software and various platforms on each of your employee's computers, you can simply access these services from anywhere through the cloud.

Whether you're writing an email, creating an invoice or collaborating on a documents, there's a cloud service solution that you can use.

How do cloud services work?

Cloud services are managed by IT service providers.

By using cloud services, your company can quickly scale both infrastructure and software. You will also lower costs as you don't need to pay for on-premises software licences, or the IT employees to perform installations and upgrades.

Different types of cloud services:

There are three basic types of cloud services:

The first is Saas, which stands for Software as a Service. This would be a software application that you could access over the cloud without having to have it installed on your device.

PaaS stands for Platform as a Service. A service provider delivers a platform to you, enabling you to develop, run, and manage business applications over the cloud.

Finally, Iaas, or Infrastructure as a Service is infrastructure delivered over the internet. This would be the actual data storage – instead of maintaining servers and physical data centres, you can access all your data seamlessly though the cloud.

- **Software as a Service (SaaS)**

  A variety of services are available as Software as a Service, including file storage, backup, web-based email and project management tools. Using one of these applications, users can access, share, store and secure information in the cloud. SaaS cloud solutions examples include Dropbox, Slack and Microsoft 365.

- **Platform as a Service (PaaS)**

  Platform as a service is an environment in the cloud where developers can build and deploy apps. PaaS provides the database and operating system that is needed to develop cloud-based software. Developers can focus on their

task, without needing to build and maintain the infrastructure that such software development processes normally require. AWS Elastic Beanstalk and Windows Azure are two cloud technology examples of PaaS.

- **Infrastructure as a Service (IaaS)**

  Infrastructure as a service provides the infrastructure that you need to manage SaaS tools, including servers, storage, and networking resources. The cloud provider would manage the storage servers and networking hardware and may also offer additional services like load balancing and firewalls.

some examples of cloud services?

Common SaaS services include Dropbox, Salesforce, Cisco WebEx. PaaS services include Google App Engine, Apache Stratos and OpenShift. Some well-known IaaS services are Amazon Web Services (AWS), Cisco Metapod and Microsoft Azure. Many of these cloud computing service examples are already familiar to us all.

Cloud services delivered

Cloud services are delivered through a public cloud, private cloud or a mix of both commonly known as hybrid cloud.

- **Public cloud services**
  Cloud services that are available over the web are referred to as public cloud services. The main benefits of a public cloud service include the ability to share resources at scale, flexibility and lower costs. The popular SaaS apps like Slack, Dropbox and Gmail are all accessible through a public cloud.
- **Private cloud services**
  With a private cloud services model, apps and data are only available through the company's internal infrastructure. Companies working with highly sensitive data often use a private cloud, which can offer them greater security.
- **Hybrid cloud services**
  Hybrid clouds combine public clouds with private clouds, with the two platforms interacting seamlessly together.

CLOUD BASED SERVICES

Cloud Computing can be defined as the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. Companies offering such kinds of cloud computing services are called *cloud providers* and typically charge for cloud computing services based on usage. Grids and clusters are the foundations for cloud computing.

Types of Cloud Computing

Most cloud computing services fall into five broad categories:

1. Software as a service (SaaS)
2. Platform as a service (PaaS)
3. Infrastructure as a service (IaaS)
4. Anything/Everything as a service (XaaS)
5. Function as a Service (FaaS)

These are sometimes called the **cloud computing stack** because they are built on top of one another. Knowing what they are and how they are different, makes it easier to accomplish your goals. These abstraction layers can also be viewed as a **layered architecture** where services of a higher layer can be composed of services of the underlying layer i.e, SaaS can provide Infrastructure.

SOFTWARE AS A SERVICE (SAAS)

Software-as-a-Service (SaaS) is a way of delivering services and applications over the Internet. Instead of installing and maintaining software, we simply access it via the Internet, freeing ourselves from the complex software and hardware management. It removes the need to install and run applications on our own computers or in the data centers eliminating the expenses of hardware as well as software maintenance.
SaaS provides a complete software solution that you purchase on a **pay-as-you-go** basis from a cloud service provider. Most SaaS applications can be run directly from a web browser without any downloads or installations required. The SaaS applications are sometimes called **Web-based software, on-demand software, or hosted software.**

Advantages of SaaS

1. **Cost-Effective:** Pay only for what you use.
2. **Reduced time:** Users can run most SaaS apps directly from their web browser without needing to download and install any software. This reduces the time spent in installation and configuration and can reduce the issues that can get in the way of the software deployment.
3. **Accessibility:** We can Access app data from anywhere.
4. **Automatic updates:** Rather than purchasing new software, customers rely on a SaaS provider to automatically perform the updates.
5. **Scalability:** It allows the users to access the services and features on-demand.

The various companies providing *Software as a service* are Cloud9 Analytics, Salesforce.com, Cloud Switch, Microsoft Office 365, Big Commerce, Eloqua, dropBox, and Cloud Tran.

PLATFORM AS A SERVICE

PaaS is a category of cloud computing that provides a platform and environment to allow developers to build applications and services over the internet. PaaS services are hosted in the cloud and accessed by users simply via their web browser.

A PaaS provider hosts the hardware and software on its own infrastructure. As a result, PaaS frees users from having to install in-house hardware and software to develop or run a new application. Thus, the development and deployment of the application take place **independent of the hardware**.

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 and possibly configuration settings for the application-hosting environment. To make it simple, take the example of an annual day function, you will have two options either to create a venue or to rent a venue but the function is the same.

Advantages of PaaS:

1. **Simple and convenient for users:** It provides much of the infrastructure and other IT services, which users can access anywhere via a web browser.
2. **Cost-Effective:** It charges for the services provided on a per-use basis thus eliminating the expenses one may have for on-premises hardware and software.
3. **Efficiently managing the lifecycle:** It is designed to support the complete web application lifecycle: building, testing, deploying, managing, and updating.
4. **Efficiency:** It allows for higher-level programming with reduced complexity thus, the overall development of the application can be more effective.

The various companies providing *Platform as a service* are Amazon Web services Elastic Beanstalk, Salesforce, Windows Azure, Google App Engine, cloud Bess and IBM smart cloud.

INFRASTRUCTURE AS A SERVICE

Infrastructure as a service (IaaS) is a service model that delivers computer infrastructure on an outsourced basis to support various operations. Typically IaaS is a service where infrastructure is provided as outsourcing to enterprises such as networking equipment, devices, database, and web servers.

It is also known as **Hardware as a Service (HaaS).** IaaS customers pay on a per-user basis, typically by the hour, week, or month. Some providers also charge customers based on the amount of virtual machine space they use.

It simply provides the underlying operating systems, security, networking, and servers for developing such applications, and services, and deploying development tools, databases, etc.

Advantages of IaaS:

1. **Cost-Effective:** Eliminates capital expense and reduces ongoing cost and IaaS customers pay on a per-user basis, typically by the hour, week, or month.
2. **Website hosting:** Running websites using IaaS can be less expensive than traditional web hosting.
3. **Security:** The IaaS Cloud Provider may provide better security than your existing software.
4. **Maintenance:** There is no need to manage the underlying data center or the introduction of new releases of the development or underlying software. This is all handled by the IaaS Cloud Provider.

The various companies providing *Infrastructure as a service* are Amazon web services, Bluestack, IBM, Openstack, Rackspace, and Vmware.

ANYTHING AS A SERVICE

It is also known as Everything as a Service. Most of the cloud service providers nowadays offer anything as a service that is a compilation of all of the above services including some additional services.

Advantages of XaaS: As this is a combined service, so it has all the advantages of every type of cloud service.

FUNCTION AS A SERVICE :

FaaS is a type of cloud computing service. It provides a platform for its users or customers to develop, compute, run and deploy the code or entire application as functions. It allows the user to entirely develop the code and update it at any time without worrying about the maintenance of the underlying infrastructure. The developed code can be executed with response to the specific event. It is also **as same as PaaS**.
FaaS is an event-driven execution model. It is implemented in the serverless container. When the application is developed completely, the user will now trigger the event to execute the code. Now, the triggered event makes response and activates the servers to execute it. The servers are nothing but the Linux servers or any other servers which is managed by the vendor completely. Customer does not have clue about any servers which is why they do not need to maintain the server hence it is **serverless architecture.**
Both PaaS and FaaS are providing the same functionality but there is still some differentiation in terms of Scalability and Cost.

FaaS, provides auto-scaling up and scaling down depending upon the demand. PaaS also provides scalability but here users have to configure the scaling parameter depending upon the demand.
In FaaS, users only have to pay for the number of execution time happened. In PaaS, users have to pay for the amount based on pay-as-you-go price regardless of how much or less they use.

Advantages of FaaS :

- **Highly Scalable:** Auto scaling is done by the provider depending upon the demand.
- **Cost-Effective:** Pay only for the number of events executed.
- **Code Simplification:** FaaS allows the users to upload the entire application all at once. It allows you to write code for independent functions or similar to those functions.
- Maintenance of code is enough and no need to worry about the servers.
- Functions can be written in any programming language.
- Less control over the system.

CLOUD COMPUTING APPLICATIONS

Cloud service providers provide various applications in the field of art, business, data storage and backup services, education, entertainment, management, social networking, etc.

The most widely used cloud computing applications are given below -

1. ART APPLICATIONS

Cloud computing offers various art applications for quickly and easily design **attractive cards, booklets,** and **images**. Some most commonly used cloud art applications are given below:
i Moo
Moo is one of the best cloud art applications. It is used for designing and printing business cards, postcards, and mini cards.

ii. Vistaprint
Vistaprint allows us to easily design various printed marketing products such as business cards, Postcards, Booklets, and wedding invitations cards.
iii. Adobe Creative Cloud
Adobe creative cloud is made for designers, artists, filmmakers, and other creative professionals. It is a suite of apps which includes PhotoShop image editing programming, Illustrator, InDesign, TypeKit, Dreamweaver, XD, and Audition.

2. Business Applications

Business applications are based on cloud service providers. Today, every organization requires the cloud business application to grow their business. It also ensures that business applications are 24*7 available to users.
There are the following business applications of cloud computing -
i. MailChimp
MailChimp is an **email publishing platform** which provides various options to **design, send,** and **save** templates for emails.
iii. Salesforce
Salesforce platform provides tools for sales, service, marketing, e-commerce, and more. It also provides a cloud development platform.
iv. Chatter
Chatter helps us to **share important information** about the organization in real time.
v. Bitrix24
Bitrix24 is a **collaboration** platform which provides communication, management, and social collaboration tools.
vi. Paypal
Paypal offers the simplest and easiest **online payment** mode using a secure internet account. Paypal accepts the payment through debit cards, credit cards, and also from Paypal account holders.
vii. Slack
Slack stands for **Searchable Log of all Conversation and Knowledge**. It provides a **user-friendly** interface that helps us to create public and private channels for communication.
viii. Quickbooks
Quickbooks works on the terminology "**Run Enterprise anytime, anywhere, on any device**." It provides online accounting solutions for the business. It allows more than 20 users to work simultaneously on the same system.

3. Data Storage and Backup Applications

Cloud computing allows us to store information (data, files, images, audios, and videos) on the cloud and access this information using an internet connection. As the cloud provider is responsible for providing security, so they offer various backup recovery application for retrieving the lost data.
A list of data storage and backup applications in the cloud are given below -
i. Box.com
Box provides an online environment for **secure content management, workflow,** and **collaboration**. It allows us to store different files such as Excel, Word, PDF, and images on the cloud. The main advantage of using box is that it provides drag & drop service for files and easily integrates with Office 365, G Suite, Salesforce, and more than 1400 tools.
ii. Mozy
Mozy provides powerful **online backup solutions** for our personal and business data. It schedules automatically back up for each day at a specific time.
iii. Joukuu
Joukuu provides the simplest way to **share** and **track cloud-based backup files**. Many users use joukuu to search files, folders, and collaborate on documents.
iv. Google G Suite
Google G Suite is one of the best **cloud storage** and **backup** application. It includes Google Calendar, Docs, Forms, Google+, Hangouts, as well as cloud storage and tools for managing cloud apps. The most popular app in the Google G Suite is Gmail. Gmail offers free email services to users.

4. Education Applications

Cloud computing in the education sector becomes very popular. It offers various **online distance learning platforms** and **student information portals** to the students. The advantage of using cloud in the field of education is that it offers strong virtual classroom environments, Ease of accessibility, secure data storage, scalability, greater reach for the students, and minimal hardware requirements for the applications.
There are the following education applications offered by the cloud -
i. Google Apps for Education

Google Apps for Education is the most widely used platform for free web-based email, calendar, documents, and collaborative study.

ii. Chromebooks for Education

Chromebook for Education is one of the most important Google's projects. It is designed for the purpose that it enhances education innovation.

iii. Tablets with Google Play for Education

It allows educators to quickly implement the latest technology solutions into the classroom and make it available to their students.

iv. AWS in Education

AWS cloud provides an education-friendly environment to universities, community colleges, and schools.

5. Entertainment Applications

Entertainment industries use a **multi-cloud strategy** to interact with the target audience. Cloud computing offers various entertainment applications such as online games and video conferencing.

i. Online games

Today, cloud gaming becomes one of the most important entertainment media. It offers various online games that run remotely from the cloud. The best cloud gaming services are Shaow, GeForce Now, Vortex, Project xCloud, and PlayStation Now.

ii. Video Conferencing Apps

Video conferencing apps provides a simple and instant connected experience. It allows us to communicate with our business partners, friends, and relatives using a cloud-based video conferencing. The benefits of using video conferencing are that it reduces cost, increases efficiency, and removes interoperability.

6. Management Applications

Cloud computing offers various cloud management tools which help admins to manage all types of cloud activities, such as resource deployment, data integration, and disaster recovery. These management tools also provide administrative control over the platforms, applications, and infrastructure.

Some important management applications are -

I. Toggl

Toggl helps users to track allocated time period for a particular project.

II. Evernote

Evernote allows you to sync and save your recorded notes, typed notes, and other notes in one convenient place. It is available for both free as well as a paid version.

It uses platforms like Windows, macOS, Android, iOS, Browser, and Unix.

III. Outright

Outright is used by management users for the purpose of accounts. It helps to track income, expenses, profits, and losses in real-time environment.

IV. GoToMeeting

GoToMeeting provides **Video Conferencing** and **online meeting apps**, which allows you to start a meeting with your business partners from anytime, anywhere using mobile phones or tablets. Using GoToMeeting app, you can perform the tasks related to the management such as join meetings in seconds, view presentations on the shared screen, get alerts for upcoming meetings, etc.

7. Social Applications

Social cloud applications allow a large number of users to connect with each other using social networking applications such as **Facebook, Twitter, LinkedIn,** etc.

There are the following cloud based social applications -

i. Facebook

Facebook is a **social networking website** which allows active users to share files, photos, videos, status, more to their friends, relatives, and business partners using the cloud storage system. On Facebook, we will always get notifications when our friends like and comment on the posts.

ii. Twitter

Twitter is a **social networking** site. It is a **microblogging** system. It allows users to follow high profile celebrities, friends, relatives, and receive news. It sends and receives short posts called tweets.

iii. Yammer

Yammer is the **best team collaboration** tool that allows a team of employees to chat, share images, documents, and videos.

iv. LinkedIn

LinkedIn is a **social network** for students, freshers, and professionals.

CLOUD COMPUTING CONCEPTS

5 Core Cloud Computing Concepts

IAAS (INFRASTRUCTURE AS A SERVICE)

Usually presented in the form of virtualization, this is the basic structure of the computer in the concept of cloud hosting. It provides customers with virtualized servers, smart storage, and secure networks through a worldwide self-service center. This means that as a user, you have flexibility in many aspects of your environment, but you also need to support middleware, operating system, software, and data. When an entrepreneur buys IaaS, they replace their physical IT assets with the cloud. This means that the seller will manage the hardware while the business manages everything that runs on it.

PAAS (PLATFORM AS A SERVICE)

It is an integrated platform for the deployment, development, support, and testing of web applications. The cloud concepts of the PaaS program is presented as a service based on the idea of cloud hosting. Although it offers advanced service to users, there is less choice about the underlying platform. It provides the tools needed to run both infrastructure and software solutions. For example, it may offer an operating system such as Windows or a database. Although the vendor manages the infrastructure and platform, it manages the business applications and data that employ the platform. This allows the business to own the solution without having to worry about the hardware and the platform they are running on.

SAAS (SOFTWARE AS A SERVICE)

This is a software license business model that supports and develops software vendors. As a user, you also have the opportunity to use the Internet to make payments. Basically, it outsources everything to the vendor, including infrastructure, software, and platforms. Because the vendor provides the same software to you and other businesses, it is usually difficult to customize the software, so you should do the same with the offer. SaaS is a very modern and sophisticated cloud model. Software services provide features that solve user problems, whether an individual or a company employee.
Some examples of solutions offered under the SaaS model include business intelligence, web conferencing, email, office automation suite, and sales force automation.

DAAS (DESKTOP AS A SERVICE)

DaaS is also known as desktops as a service and provides secure access to virtual apps and desktops from the cloud to any device across the world. This desktop virtualization solution saves SaaS and legacy applications, as well as full Windows-based virtual desktops, and adds them to your workforce. DaaS offers a simple and foreseeable pay-as-you-need subscription model, which makes it easy to use for an increase or decrease demand. This trunk service is easy to manage and simplifies many IT admin tasks with desktop solutions.

DATA SECURITY AND PRIVACY

During the last 20 years, software systems had conquered an essential critical role in society, because of which now we are totally dependent upon the computerized systems. Besides, the use of computerized systems needs for a high level of security is the major obstacle in the world of computing. As a new technology, cloud computing is in use these days because of its features.
As data has moved into the cloud, security concerns are growing because it is strange to put your data on someone else's hard disk and use someone else's CPU. Therefore, security issues arise. The user must rely on the cloud computing provider's promise for data security and privacy. The main dimensions of security are confidentiality, integrity, privacy, and availability. Security is the prevention of unauthorized access, prevention of altering the data, prevention of withholding the recourses, prevention of disclosure of information. That's because, the data is stored in the clouds and can be accessed anywhere in the world. So, the security and privacy of stored data can be compromised.
Cloud computing technology is controlled and managed by third parties. That's why it raises questions about the confidentiality of our business data.

There are many cloud computing concepts, and the domain is expanding very fast with each passing day. Professionals planning to advance their careers in their field should be well prepared to keep up with the latest inventions in the field.

Besides, cloud computing has a special relationship between the end-user and the cloud provider. Although, cloud computing has its own strengths related to security factors.
Some cloud computing issues have been resolved due to large scale security and privacy issues, need to be addressed. Attempts are currently being made to overcome 5 security threats. These include privacy, integrity, availability, authentication audits, and controls. It is a well-known fact that cloud computing has a bright future. But we need to address these issues to make them more usable. In the future, the focus of this cutting-edge technology will be on security and privacy from a security standpoint.

CLOUD COMPUTING TECHNOLOGIES

A list of cloud computing technologies are given below -

- Virtualization
- Service-Oriented Architecture (SOA)
- Grid Computing
- Utility Computing

VIRTUALIZATION

Virtualization is the process of creating a virtual environment to run multiple applications and operating systems on the same server. The virtual environment can be anything, such as a single instance or a combination of many operating systems, storage devices, network application servers, and other environments.
The concept of Virtualization in cloud computing increases the use of virtual machines. A virtual machine is a software computer or software program that not only works as a physical computer but can also function as a physical machine and perform tasks such as running applications or programs as per the user's demand.

TYPES OF VIRTUALIZATION

A list of types of Virtualization is given below -

i. Hardware virtualization
ii. Server virtualization
iii. Storage virtualization
iv. Operating system virtualization
v. Data Virtualization

SERVICE-ORIENTED ARCHITECTURE (SOA)

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

APPLICATIONS OF SERVICE-ORIENTED ARCHITECTURE

There are the following applications of Service-Oriented Architecture -

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

The service-oriented architecture is shown below:

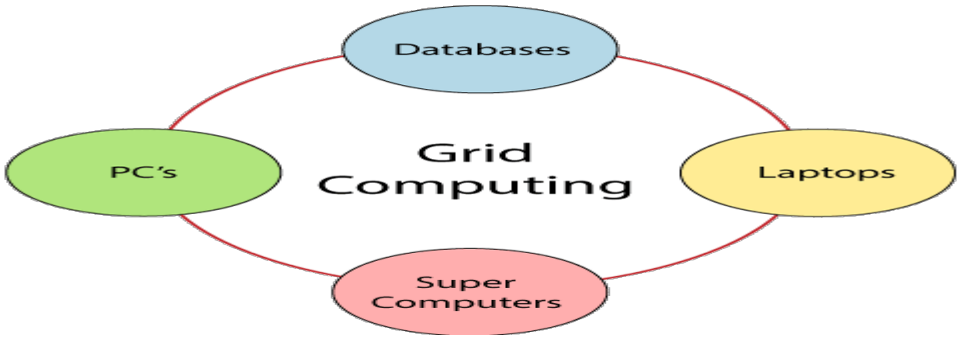
GRID COMPUTING

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

Grid computing contains the following three types of machines -

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

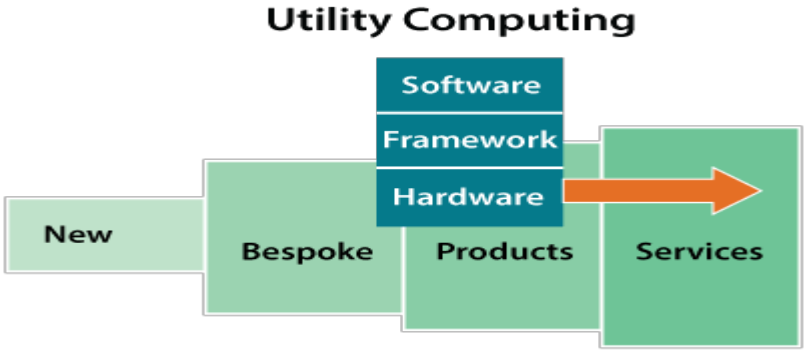
Mainly, grid computing is used in the **ATMs, back-end infrastructures,** and **marketing research**.



UTILITY COMPUTING

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

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



VIRTUALIZATION IN CLOUD COMPUTING

Virtualization is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources".

In other words, Virtualization is a technique, which allows to share a single physical instance of a resource or an application among multiple customers and organizations. It does by assigning a logical name to a physical storage and providing a pointer to that physical resource when demanded.

TYPES OF VIRTUALIZATION:

1. Hardware Virtualization.
2. Operating system Virtualization.
3. Server Virtualization.
4. Storage Virtualization.

1) HARDWARE VIRTUALIZATION :

When the virtual machine software or virtual machine manager *(VMM) is directly installed on the hardware system* is known as hardware virtualization.

The main job of hypervisor is to control and monitoring the processor, memory and other hardware resources.
After virtualization of hardware system we can install different operating system on it and run different applications on those OS.

Usage:

Hardware virtualization is mainly done for the server platforms, because controlling virtual machines is much easier than controlling a physical server.

2) Operating System Virtualization :

When the virtual machine software or virtual machine manager *(VMM) is installed on the Host operating system* instead of directly on the hardware system is known as operating system virtualization.

Usage:

Operating System Virtualization is mainly used for testing the applications on different platforms of OS.

3) Server Virtualization :

When the virtual machine software or virtual machine manager *(VMM) is directly installed on the Server system* is known as server virtualization.

Usage:

Server virtualization is done because a single physical server can be divided into multiple servers on the demand basis and for balancing the load.

4) Storage Virtualization :

Storage virtualization is the *process of grouping the physical storage from multiple network storage devices so that it looks like a single storage device*.

Storage virtualization is also implemented by using software applications.

Usage:

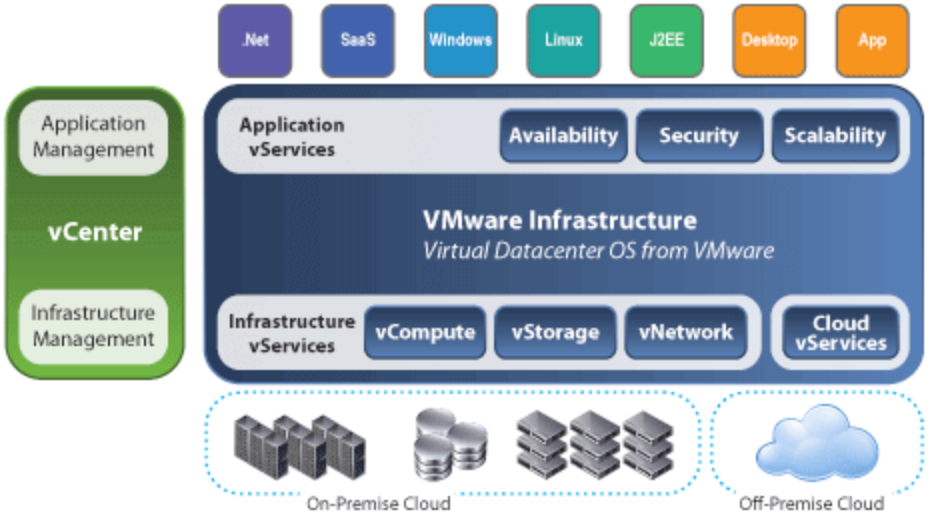
Storage virtualization is mainly done for back-up and recovery purposes.

How does virtualization work in cloud computing ?

Virtualization plays a very important role in the cloud computing technology, normally in the cloud computing, users share the data present in the clouds like application etc, but actually with the help of virtualization users shares the Infrastructure.

The **main usage of Virtualization Technology** is to provide the applications with the standard versions to their cloud users, suppose if the next version of that application is released, then cloud provider has to provide the latest version to their cloud users and practically it is possible because it is more expensive.

To overcome this problem we use basically virtualization technology, By using virtualization, all severs and the software application which are required by other cloud providers are maintained by the third party people, and the cloud providers has to pay the money on monthly or annual basis.



LOAD BALANCING

Load Balancing is the method that allows you to create a proper balance of the amount of work that is being performed on various pieces of device or hardware equipment. Usually, what happens is that loads of the devices are balanced amongst different servers or inside a single Cloud server between CPUs and hard drives.
Load Balancing was introduced for various reasons. One of them is to better the speed and performance of every single device and the other is to keep saving individual devices from hitting their threshold by dropping down their performance.

Types of Load Balancing Algorithms in Cloud Computing:

1. STATIC ALGORITHM

Static Algorithms are made for those systems which have very low variations in load. In Static Algorithm, the entire traffic is equally divided amongst the servers. This algorithm needs an in-depth knowledge of server resources for better performance of the processors which is determined at the beginning of the implementation.
However, the decision of load shifting does not depend on the present state of the system. There is one major drawback of Static Load Balancing Algorithm that is load balancing tasks work only after they are created, it could not be implemented to other devices for load balancing.

2. DYNAMIC ALGORITHM

Dynamic Algorithm first searches the lightest server in the entire network and gives it the preference for load balancing. It requires real time communication with the network that can help in increasing the traffic of the system. Here, the present state of the system is used to control the load.
The specialty of Dynamic Algorithm is to make load transfer decisions to the actual current system state. In this system, processes are allowed to move from a highly utilized machine from under utilized machine in real time.

3. ROUND ROBIN ALGORITHM

This is amongst the easiest methods of load balancing. As the name suggests, Round Robin Load Balancing Algorithm uses the round-robin method for assigning the jobs. Firstly, it chooses the first node on a random basis and assigns the tasks to the other nodes in round robin way.
Processors circularly assign each process without defining any priority. This results in a faster response in case of similar workload distribution among the processes. All the processes have different loading time. Therefore, some nodes might be heavily loaded, while the others may remain under-utilized.

4. WEIGHTED ROUND ROBIN LOAD BALANCING ALGORITHM

Weighted Round Robin Load Balancing Algorithm is developed to enhance the most challenging issues of Round Robin Algorithm. In this algorithm, there is a designated prescribed weight and jobs which are distributed as per the values of the weight.
Those processors that have greater abilities are assigned a bigger value. Therefore, highest weighted servers will get more tasks. When the entire weights come in level, servers will get steady traffic.

5. OPPORTUNISTIC LOAD BALANCING ALGORITHM

Opportunistic Load Balancing Algorithm allows keeping each node busy. It never considers the current workload of each system. Regardless of the current workload on each of the nodes, OLB distributes all the unfinished tasks to these nodes randomly.
The processing task will be executed slowly as OLB, it doesn't calculate the implementation timing of the node due to which some bottlenecks arise even when some nodes are free.

6. MINIMUM TO MINIMUM LOAD BALANCING ALGORITHM

Under Minimum To Minimum Load Balancing Algorithms, firstly, those tasks are found which takes minimum completion time. Out of those, a minimum value is selected among all the tasks. As per that minimum time, the task is scheduled on the machine.
Similar to this, the other tasks have been updated on the machine, and the task is then removed from that list. This procedure will continue till the last task is assigned. This Algorithm seems to be the best where many smaller tasks are more than large tasks.

7. MAXIMUM TO MINIMUM LOAD BALANCING ALGORITHM

Maximum to Minimum Load Balancing Algorithm is almost same as the previous one. But there is a slight difference in this Algorithm. Here maximum value is selected after searching out the minimum implementation time. After then, as per the maximum period, the task is scheduled on the machine. The execution time of all the tasks are updated and the assigned task is removed from the list.

SCALABILITY

In cloud computing, the term cloud scalability refers to the capacity to improve or reduce IT resources, depending on the requirement changing demand. In other words, we can say that scalability is employed to satisfy the static growth in the workload.

ELASTICITY

Elasticity refers to the capability of a cloud to automatically boost or shorten the infrastructural resources, depending on the requirement so that the workload can be handled efficiently. This elasticity also helps in reducing the infrastructural expenditure.

DIFFERENCE BETWEEN SCALABILITY AND ELASTICITY IN CLOUD COMPUTING

S.No.	Cloud Elasticity	Cloud Scalability
1	It is used just to fulfil the sudden requirement in the workload for a short period.	It is used to fulfil the static boost in the workload.
2	It is preferred to satisfy the dynamic modifications, where the required resources can improve or reduce.	It is preferred to handle growth in the workload in an organisation.
3	Cloud elasticity is generally used by small enterprises whose workload expands only for a specific period.	Cloud scalability is utilised by big enterprises.
4	It is a short term event that is used to deal with an unplanned or sudden growth in demand.	It is a long term event that is used to deal with an expected growth in demand.

CLOUD DEPLOYMENT MODELS

In cloud computing, we have access to a shared pool of computer resources (servers, storage, programs, and so on) in the cloud. You simply need to request additional resources when you require them. Getting resources up and running quickly is a breeze thanks to the clouds. It is possible to release resources that are no longer necessary. This method allows you to just pay for what you use. Your cloud provider is in charge of all upkeep. It functions as a virtual computing environment with a deployment architecture that varies depending on the amount of data you want to store and who has access to the infrastructure.

DEPLOYMENT MODELS

The cloud deployment model identifies the specific type of cloud environment based on ownership, scale, and access, as well as the cloud's nature and purpose. The location of the servers you're utilizing and who controls them are defined by a cloud deployment model. It specifies how your cloud infrastructure will look, what you can change, and whether you will be given services or will have to create everything yourself. Relationships between the infrastructure and your users are also defined by cloud deployment types.

Different types of cloud computing deployment models are:

1. Public cloud
2. Private cloud
3. Hybrid cloud
4. Community cloud
5. Multi-cloud

Let us discuss them one by one:

1. Public Cloud

The public cloud makes it possible for anybody to access systems and services. The public cloud may be less secure as it is open for everyone. The public cloud is one in which cloud infrastructure services are provided over the internet to the general people or major industry groups. The infrastructure in this cloud model is owned by the entity that delivers the cloud services, not by the consumer. It is a type of cloud hosting that allows customers and users to easily access systems and services. This form of cloud computing is an excellent example of cloud hosting, in which service providers supply services to a variety of customers. In this arrangement, storage backup and retrieval services are given for free, as a subscription, or on a per-use basis. Example: Google App Engine etc.

Advantages of the public cloud model:

- **Minimal Investment:** Because it is a pay-per-use service, there is no substantial upfront fee, making it excellent for enterprises that require immediate access to resources.
- **No setup cost:** The entire infrastructure is fully subsidized by the cloud service providers, thus there is no need to set up any hardware.
- **Infrastructure Management is not required:** Using the public cloud does not necessitate infrastructure management.
- **No maintenance:** The maintenance work is done by the service provider (Not users).
- **Dynamic Scalability:** To fulfill your company's needs, on-demand resources are accessible.

2. Private Cloud

The private cloud deployment model is the exact opposite of the public cloud deployment model. It's a one-on-one environment for a single user (customer). There is no need to share your hardware with anyone else. The distinction between private and public cloud is in how you handle all of the hardware. It is also called the "internal cloud" & it refers to the ability to access systems and services within a given border or organization. The cloud platform is implemented in a cloud-based secure environment that is protected by powerful firewalls and under the supervision of an organization's IT department.
The private cloud gives the greater flexibility of control over cloud resources.

Advantages of the private cloud model:

- **Better Control:** You are the sole owner of the property. You gain complete command over service integration, IT operations, policies, and user behavior.
- **Data Security and Privacy:** It's suitable for storing corporate information to which only authorized staff have access. By segmenting resources within the same infrastructure, improved access and security can be achieved.
- **Supports Legacy Systems:** This approach is designed to work with legacy systems that are unable to access the public cloud.
- **Customization:** Unlike a public cloud deployment, a private cloud allows a company to tailor its solution to meet its specific needs.

3. Hybrid cloud

By bridging the public and private worlds with a layer of proprietary software, hybrid cloud computing gives the best of both worlds. With a hybrid solution, you may host the app in a safe environment while taking advantage of the public cloud's cost savings. Organizations can move data and applications between different clouds using a combination of two or more cloud deployment methods, depending on their needs.

Advantages of the hybrid cloud model:

- **Flexibility and control:** Businesses with more flexibility can design personalized solutions that meet their particular needs.
- **Cost:** Because public clouds provide for scalability, you'll only be responsible for paying for the extra capacity if you require it.
- **Security:** Because data is properly separated, the chances of data theft by attackers are considerably reduced.

4. Community cloud

It allows systems and services to be accessible by a group of organizations. It is a distributed system that is created by integrating the services of different clouds to address the specific needs of a community, industry, or business. The infrastructure of the community could be shared between the organization which has shared concerns or tasks. It is generally managed by a third party or by the combination of one or more organizations in the community.

Advantages of the community cloud model:

- **Cost Effective:** It is cost-effective because the cloud is shared by multiple organizations or communities.
- **Security:** Community cloud provides better security.
- **Shared resources:** It allows you to share resources, infrastructure, etc. with multiple organizations.
- **Collaboration and data sharing:** It is suitable for both collaboration and data sharing.

5. Multi-cloud

We're talking about employing multiple cloud providers at the same time under this paradigm, as the name implies. It's similar to the hybrid cloud deployment approach, which combines public and private cloud resources. Instead of merging private and public clouds, multi-cloud uses many public clouds. Although public cloud providers provide numerous tools to improve the reliability of their services, mishaps still occur. It's quite rare that two distinct clouds would have an incident at the same moment. As a result, multi-cloud deployment improves the high availability of your services even more.

Advantages of a multi-cloud model:

- You can mix and match the best features of each cloud provider's services to suit the demands of your apps, workloads, and business by choosing different cloud providers.
- **Reduced Latency:** To reduce latency and improve user experience, you can choose cloud regions and zones that are close to your clients.
- **High availability of service:** It's quite rare that two distinct clouds would have an incident at the same moment. So, the multi-cloud deployment improves the high availability of your services.

Benefits of cloud deployment:

With an effective cloud deployment model, an organization achieves numerous benefits, including:

Faster and simplified deployments. **Automate builds that deploy code, databases and application releases, including resource provisioning.**

Cost savings. **Control costs using consumption-based pricing and eliminate capex-heavy on-premises environments.**

Platform for growth. **Leverage the global infrastructure provided by cloud service providers (CSPs) to seamlessly expand the business into other geographies.**

New digital business models. **Exploit the continuous release of features and services by CSPs, incubate new technologies and innovate digital business models.**

Business resiliency. **Architect for the availability and fault-tolerance CSPs offer and ensure disaster recovery and business continuity of applications to make the business resilient.**

Agility and scalability. **Use autoscaling and scalability to meet peak demands of the business without provisioning for excess capacity.**

Geographic reach. **Access applications from any location, on any device, leveraging the connectivity backbone of CSPs.**

Operational efficiency. **Use the inherent automation enabled by cloud to increase operational efficiency and reduce human effort.**

A competitive edge. **Leverage infrastructure as code and development, security and operations (DevSecOps) to reduce the time to market for new features and stay ahead of the competition.**

Empowered users. **Increase productivity by empowering users with self-service options on cloud, such as portals, DevOps pipelines and executive and operational dashboards.**

DATA REPLICATION

Data replication is the process of making multiple copies of data and storing them at different locations for backup purposes, fault tolerance and to improve their overall accessibility across a network. Similar to data mirroring, data replication can be applied to both individual computers and servers. The data replicates can be stored within the same system, on-site and off-site hosts, and cloud-based hosts.

Common database technologies today either have built-in capabilities, or use third-party tools to accomplish data replication. While Oracle Database and Microsoft SQL actively support data replication, some traditional technologies may not include this feature out of the box.

Data replication can either be synchronous, meaning that any changes made to the original data will be replicated, or asynchronous, meaning replication is initiated only when the Commit statement is passed to the database.

BENEFITS OF DATA REPLICATION

Although data replication can be demanding in terms of cost, computational, and storage requirements, businesses widely use this database management technique to achieve one or more of the following goals:

1. Improve the availability of data
2. Increase the speed of data access
3. Enhance server performance
4. Accomplish disaster recovery

Cloud Monitoring

Cloud Monitoring collects metrics, events, and metadata from Google Cloud, Amazon Web Services (AWS), hosted uptime probes, and application instrumentation. Using the BindPlane service, you can also collect this data from over 150 common application components, on-premise systems, and hybrid cloud systems. Google Cloud's operations suite ingests that data and generates insights via dashboards, charts, and alerts. BindPlane is included with your Google Cloud project at no additional cost.

Software-Defined Networking

Software-Defined Networking (SDN) is a network architecture approach that enables the network to be intelligently and centrally controlled, or 'programmed,' using software applications. This helps operators manage the entire network consistently and holistically, regardless of the underlying network technology.
here are four critical areas in which SDN technology can make a difference for an organization.

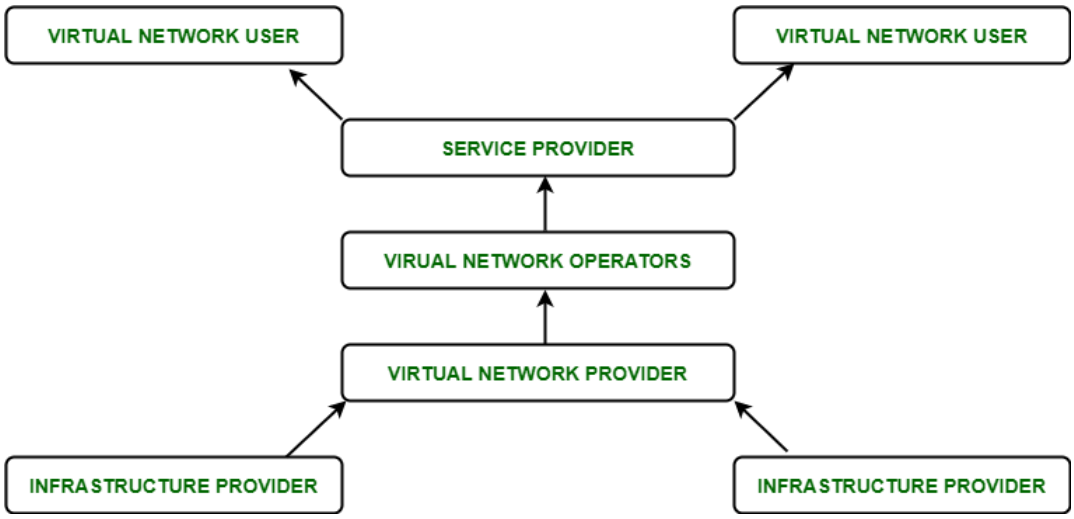
1) Network programmability: SDN enables network behavior to be controlled by the software that resides beyond the networking devices that provide physical connectivity. As a result, network operators can tailor the behavior of their networks to support new services, and even individual customers. By decoupling the hardware from the software, operators can introduce innovative, differentiated new services rapidly—free from the constraints of closed and proprietary platforms.

2) Logically centralize intelligence and control: SDN is built on logically centralized network topologies, which enable intelligent control and management of network resources. Traditional network control methods are distributed. Devices function autonomously with limited awareness of the state of the network. With the kind of centralized control an SDN-based network provides, bandwidth management, restoration, security, and policies can be highly intelligent and optimized—and an organization gains a holistic view of the network.
3) Abstraction of the network: Services and applications running on SDN technology are abstracted from the underlying technologies and hardware that provide physical connectivity from network control. Applications will interact with the network through APIs, instead of management interfaces tightly coupled to the hardware.

4) Openness: SDN architectures usher in a new era of openness—enabling multi-vendor interoperability as well as fostering a vendor-neutral ecosystem. Openness comes from the SDN approach itself. The open APIs support a wide range of applications, including cloud orchestration, OSS/BSS, SaaS, and business-critical networked apps. In addition, intelligent software can control hardware from multiple vendors with open programmatic interfaces like OpenFlow. Finally, from within the SDN, intelligent network services and applications can run within a common software environment

NETWORK VIRTUALIZATION IN CLOUD COMPUTING

Network Virtualization is a process of logically grouping physical networks and making them operate as single or multiple independent networks called Virtual Networks.



Tools for Network Virtualization :

1. **Physical switch OS** –
   It is where the OS must have the functionality of network virtualization.
2. **Hypervisor –**

3. It is which uses third-party software or built-in networking and the functionalities of network virtualization.

The basic functionality of the OS is to give the application or the executing process with a simple set of instructions. System calls that are generated by the OS and executed through the libc library are comparable to the service primitives given at the interface between the application and the network through the SAP (Service Access Point). The hypervisor is used to create a virtual switch and configuring virtual networks on it. The third-party software is installed onto the hypervisor and it replaces the native networking functionality of the hypervisor. A hypervisor allows us to have various VMs all working optimally on a single piece of computer hardware.

Functions of Network Virtualization :

- It enables the functional grouping of nodes in a virtual network.
- It enables the virtual network to share network resources.
- It allows communication between nodes in a virtual network without routing of frames.
- It restricts management traffic.
- It enforces routing for communication between virtual networks.

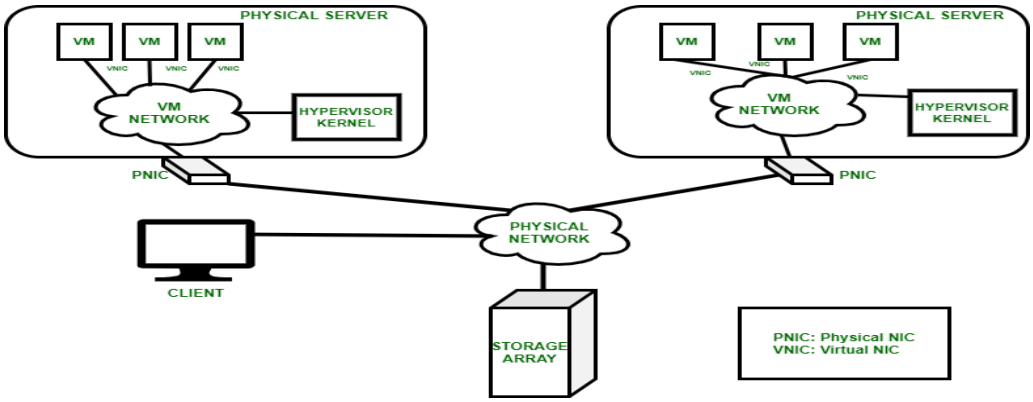
Network Virtualization in Virtual Data Center :

1. Physical Network

- Physical components: Network adapters, switches, bridges, repeaters, routers and hubs.
- Grants connectivity among physical servers running a hypervisor, between physical servers and storage systems and between physical servers and clients.

2. VM Network

- Consists of virtual switches.
- Provides connectivity to hypervisor kernel.
- Connects to the physical network.
- Resides inside the physical ser



Advantages of Network Virtualization :

Improves manageability –
- Grouping and regrouping of nodes are eased.
- Configuration of VM is allowed from a centralized management workstation using management software.

Reduces CAPEX –
- The requirement to set up separate physical networks for different node groups is reduced.

Improves utilization –
- Multiple VMs are enabled to share the same physical network which enhances the utilization of network resource.

Enhances performance –
- Network broadcast is restricted and VM performance is improved.

Enhances security –
- Sensitive data is isolated from one VM to another VM.
- Access to nodes is restricted in a VM from another VM.

Disadvantages of Network Virtualization :

- It needs to manage IT in the abstract.
- It needs to coexist with physical devices in a cloud-integrated hybrid environment.
- Increased complexity.
- Upfront cost.
- Possible learning curve.

Examples of Network Virtualization :

Virtual LAN (VLAN) –
- The performance and speed of busy networks can be improved by VLAN.
- VLAN can simplify additions or any changes to the network.

Network Overlays –
- A framework is provided by an encapsulation protocol called VXLAN for overlaying virtualized layer 2 networks over layer 3 networks.
- The Generic Network Virtualization Encapsulation protocol (GENEVE) provides a new way to encapsulation designed to provide control-plane independence between the endpoints of the tunnel.

Network Virtualization Platform: VMware NSX –
- VMware NSX Data Center transports the components of networking and security such as switching, firewalling and routing that are defined and consumed in software.
- It transports the operational model of a virtual machine (VM) for the network.

Applications of Network Virtualization :

- Network virtualization may be used in the development of application testing to mimic real-world hardware and system software.
- It helps us to integrate several physical networks into a single network or separate single physical networks into multiple analytical networks.
- In the field of application performance engineering, network virtualization allows the simulation of connections between applications, services, dependencies, and end-users for software testing.
- It helps us to deploy applications in a quicker time frame, thereby supporting a faster go-to-market.
- Network virtualization helps the software testing teams to derive actual results with expected instances and congestion issues in a networked environment.

MapReduce

MapReduce is a programming paradigm that enables massive scalability across hundreds or thousands of servers in a Hadoop cluster. As the processing component, MapReduce is the heart of Apache Hadoop. The term "MapReduce" refers to two separate and distinct tasks that Hadoop programs perform. The first is the map job, which takes a set of data and converts it into another set of data, where individual elements are broken down into tuples (key/value pairs).
The reduce job takes the output from a map as input and combines those data tuples into a smaller set of tuples. As the sequence of the name MapReduce implies, the reduce job is always performed after the map job.

MapReduce programming offers several benefits to help you gain valuable insights from your big data:

- **Scalability**. Businesses can process petabytes of data stored in the Hadoop Distributed File System (HDFS).
- **Flexibility**. Hadoop enables easier access to multiple sources of data and multiple types of data.
- **Speed**. With parallel processing and minimal data movement, Hadoop offers fast processing of massive amounts of data.
- **Simple**. Developers can write code in a choice of languages, including Java, C++ and Python.

Identity and Access Management

Identity and access management functional architecture

We'll present the basic concepts and definitions of IAM functions for any service:

Authentication

Authentication is the process of verifying the identity of a user or system. Authentication usually connotes a more robust form of identification. In some use cases, such as service-to-service interaction, authentication involves verifying the network service requesting access to information served by another service.

Authorization

Authorization is the process of determining the privileges the user or system is entitled to once the identity is established. —in other words, authorization is the process of enforcing policies.

Auditing

In the context of IAM, auditing entails the process of review and examination of authentication, authorization records, and activities to determine the adequacy of IAM system controls, to verify compliance with established security policies and procedures (e.g., separation of duties), to detect breaches in security services (e.g., privilege escalation), and to recommend any changes that are indicated for countermeasures.

IAM Architecture

Standard enterprise IAM architecture encompasses several layers of technology, services, and processes. At the core of the deployment architecture is a directory service (such as LDAP or Active Directory) that acts as a repository for the identity, credential, and user attributes of the organization's user pool. The directory interacts with IAM technology components such as authentication, user management, provisioning, and federation services that support the standard IAM practice and processes within the organization. It is not uncommon for organizations to use several directories that were deployed for environment-specific reasons (e.g., Windows systems using Active Directory, Unix systems using LDAP) or that were integrated into the environment by way of business mergers and acquisitions.

The IAM processes to support the business can be broadly categorized as follows:

User management
Activities for the effective governance and management of identity life cycles

Authentication management
Activities for the effective governance and management of the process for determining that an entity is who or what it claims to be

Authorization management
Activities for the effective governance and management of the process for determining entitlement rights that decide what resources an entity is permitted to access in accordance with the organization's policies.

Access management
Enforcement of policies for access control in response to a request from an entity (user, services) wanting to access an IT resource within the organization

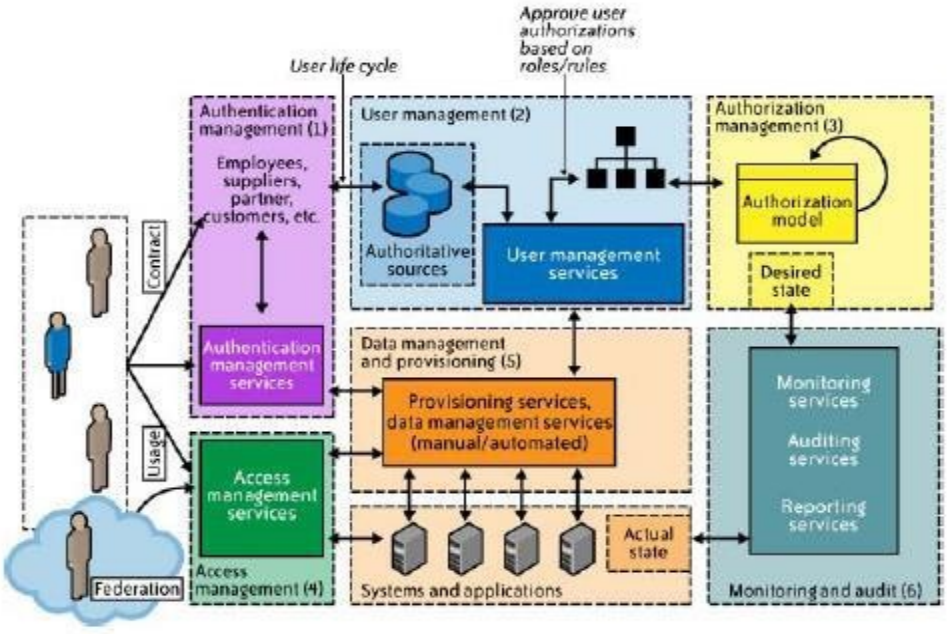
Data management and provisioning
Propagation of identity and data for authorization to IT resources via automated or manual processes

Monitoring and auditing
Monitoring, auditing, and reporting compliance by users regarding access to resources within the organization based on the defined policies.

IAM processes support the following operational activities:

Provisioning
This is the process of on-boarding users to systems and applications. These processes provide users with necessary access to data and technology resources. The term typically is used in reference to enterprise-level resource management.

Credential and attribute management
These processes are designed to manage the life cycle of credentials and user attributes— create, issue, manage, revoke—to minimize the business risk associated with identity impersonation and inappropriate account use. Credentials are usually bound to an individual and are verified during the authentication process. The processes include provisioning of attributes, static (e.g., standard text password) and dynamic (e.g., one-time password) credentials that comply with a password standard (e.g., passwords resistant to dictionary attacks), handling password expiration, encryption management of credentials during transit and at rest, and access policies of user attributes



Enterprise IAM functional architecture

Entitlement management
Entitlements are also referred to as *authorization policies*. The processes in this domain address the provisioning and deprovisioning of privileges needed for the user to access resources including systems, applications, and databases.

Compliance management
This process implies that access rights and privileges are monitored and tracked to ensure the security of an enterprise's resources. The process also helps auditors verify compliance to various internal access control policies, and standards that include practices such as segregation of duties, access monitoring, periodic auditing, and reporting.

Identity federation management
Federation is the process of managing the trust relationships established beyond the internal network boundaries or administrative domain boundaries among distinct organizations. A federation is an association of organizations that come together to exchange information about their users and resources to enable collaborations and transactions

SERVICE LEVEL AGREEMENTS IN CLOUD COMPUTING

A **Service Level Agreement (SLA)** is the bond for performance negotiated between the cloud services provider and the client. Earlier, in cloud computing all Service Level Agreements were negotiated between a client and the service consumer. Nowadays, with the initiation of large utility-like cloud computing providers, most Service Level Agreements are standardized until a client becomes a large consumer of cloud services.

Service level agreements are also defined at **different levels** which are mentioned below:
- Customer-based SLA
- Service-based SLA
- Multilevel SLA

Few Service Level Agreements are enforceable as contracts, but mostly are agreements or contracts which are more along the lines of an Operating Level Agreement (OLA) and may not have the restriction of law. It is fine to have an attorney review the documents before making a major agreement to the cloud service provider.

Service Level Agreements usually specify **some parameters** which are mentioned below:
1. Availability of the Service (uptime)
2. Latency or the response time
3. Service components reliability
4. Each party accountability
5. Warranties

In any case, if a cloud service provider fails to meet the stated targets of minimums then the provider has to pay the penalty to the cloud service consumer as per the agreement. So, Service Level Agreements are like insurance policies in which the corporation has to pay as per the agreements if any casualty occurs.
Microsoft publishes the Service Level Agreements linked with the Windows Azure Platform components, which is demonstrative of industry practice for cloud service vendors. Each individual component has its own Service Level Agreements.

Below are two **major Service Level Agreements (SLA)** described:
1. **Windows Azure SLA –**
   Window Azure has different SLA's for compute and storage. For compute, there is a guarantee that when a client deploys two or more role instances in separate fault and upgrade domains, client's internet facing roles will have external connectivity minimum 99.95% of the time. Moreover, all of the role instances of the client are monitored and there is guarantee of detection 99.9% of the time when a role instance's process is not runs and initiates properly.
2. **SQL Azure SLA –**
   SQL Azure clients will have connectivity between the database and internet gateway of SQL Azure. SQL Azure will handle a "Monthly Availability" of 99.9% within a month. Monthly Availability Proportion for a particular tenant database is the ratio of the time the database was available to customers to the total time in a month. Time is measured in some intervals of minutes in a 30-day monthly cycle. Availability is always remunerated for a complete month. A portion of time is marked as unavailable if the customer's attempts to connect to a database are denied by the SQL Azure gateway.

Service Level Agreements are based on the usage model. Frequently, cloud providers charge their pay-as-per-use resources at a premium and deploy standards Service Level Agreements only for that purpose. Clients can also subscribe at different levels that guarantees access to a particular amount of purchased resources. The Service Level Agreements (SLAs) attached to a subscription many times offer various terms and conditions. If client requires access to a particular level of resources, then the client need to subscribe to a service. A usage model may not deliver that level of access under peak load condition.

Billing Systems

A billing system automates much of the manual work required to create an accurate invoice. Billing systems typically track the following:

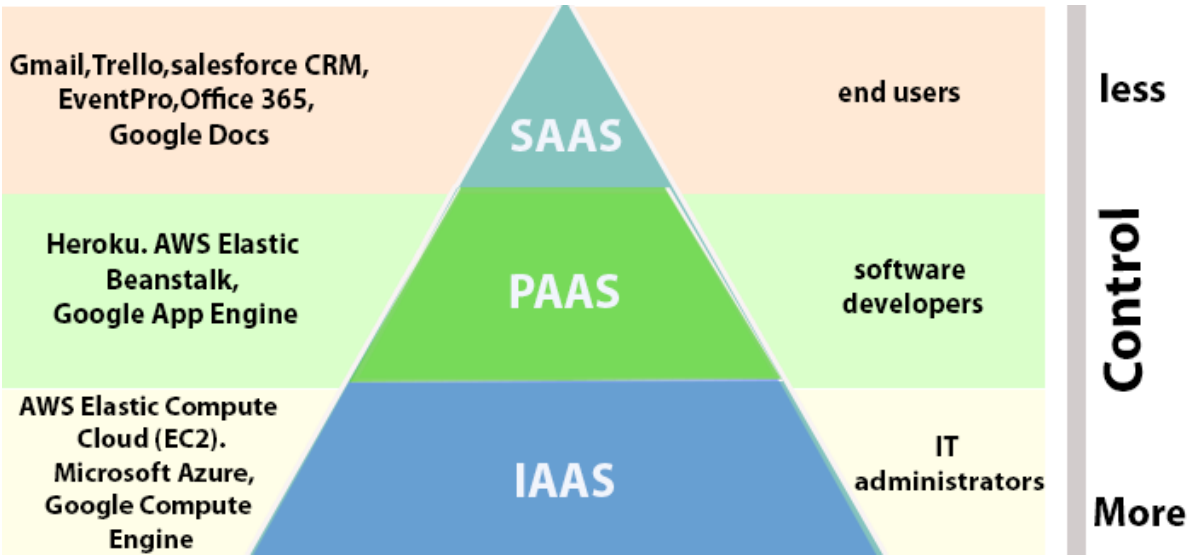
- Actual product/service usage
- Client provisioning
- Discounts
- Payment Plans
- Subscription tiers
- Customized services and pricing
- Tax levies
- Billing automation systems then automatically generate customer invoices, either directly or through integration with an accounting system. This process delivers a more efficient way of invoicing customers.

Automated billing systems like Work 365 help CSPs send and track more accurate invoices to they get paid more quickly with less effort.

When integrated with an accounting system, Work 365 can help businesses:

- Streamline processes by unifying all data collection and tracking into a fully integrated front to back system.
- Save time by allowing the creation of things like payment plans, auto-pay services, tax calculations, and automated invoicing and payment reminders that are action triggered and not manual.
- Offer better service self-service portals allow customers to view their balance, understand their charges, and pay on their own. This lets your business focus its resources on improving support rather than reconciling accounts
- Make fewer mistakes in automated services decrease manual actions that lead to errors.

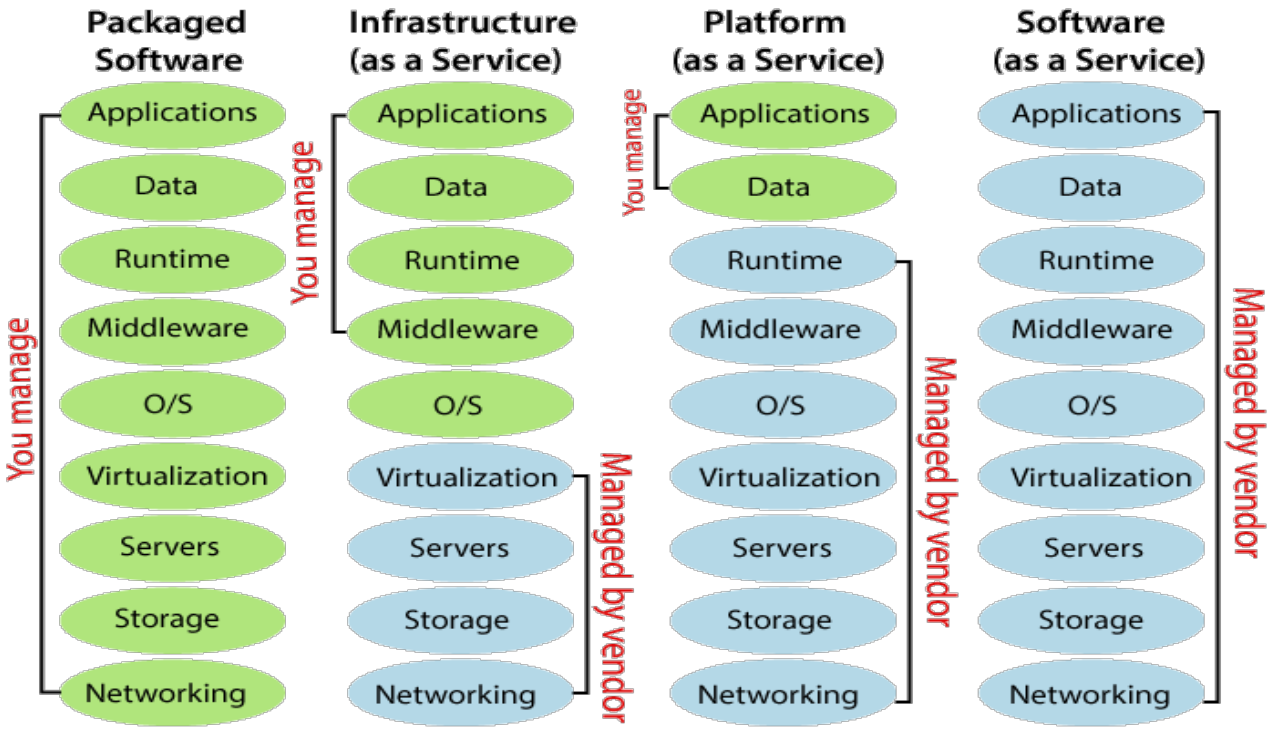
Types of Cloud Services



1. **Infrastructure as a Service (IaaS):** In IaaS, we can rent IT infrastructures like servers and virtual machines (VMs), storage, networks, operating systems from a cloud service vendor. We can create VM running Windows or Linux and install anything we want on it. Using IaaS, we don't need to care about the hardware or virtualization software, but other than that, we do have to manage everything else. Using IaaS, we get maximum flexibility, but still, we need to put more effort into maintenance.
2. **Platform as a Service (PaaS):** This service provides an on-demand environment for developing, testing, delivering, and managing software applications. The developer is responsible for the application, and the PaaS

vendor provides the ability to deploy and run it. Using PaaS, the flexibility gets reduce, but the management of the environment is taken care of by the cloud vendors.

3. **Software as a Service (SaaS):** It provides a centrally hosted and managed software services to the end-users. It delivers software over the internet, on-demand, and typically on a subscription basis. E.g., Microsoft One Drive, Dropbox, WordPress, Office 365, and Amazon Kindle. SaaS is used to minimize the operational cost to the maximum extent.



STORAGE SERVICES:

Amazon, Microsoft and Google is the three largest public cloud storage providers.

The internet has drastically changed the IT industry. It not only connects a person with the world, but it also introduces new features every year. In the last decade, "cloud" was a new term tossed in the market, and soon it gained so much popularity that it now covers a large area of the industry.
Up to some extent, we all are familiar with cloud technology and how it stores our data at remote locations, and now every big tech company uses this technology to save their own and customers' data. Cloud is not only limited to large organizations or enterprises but now even ordinary people also use the cloud to store their data.
Cloud has become so popular that every big tech giant has its cloud service. For example, if you are an android user, you have to connect your mobile device to a Google drive. This will store your data at a remote location, so even if your mobile gets lost or reset, you can recover your data from the remote server.
If you are looking to further your knowledge and learn the basics of cloud computing, head over to Cloud Academy and check out Cloud Literacy. Whether you're involved in sourcing IT services, need to understand the cloud to make your business work more efficiently, or just want to know about what the cloud is, this learning path is for you.

CLOUD:
In the software industry, cloud means a service that runs on the internet and stores your data at a "remote location," which means the data center of a cloud service provider. In cloud storage, the data that you have stored at your device or hard drive can be stored at the data center of the cloud service provider. The cloud service storage works as a bank that stores your data so you can access it from anywhere and any device.

CLOUD STORAGE WORK :
Cloud storage works on a client-server model, in which a client sends the request to the subscribed cloud service storage and the server at the data center gives the appropriate response. The main objective of the cloud, instead of saving data at local storage, the data of the user can be collected at some data center so the user could retrieve his or her data from any device.

Plans	Storage Capacity	Price
Standard	5GB	• $15 (Monthly) • $12.5 (yearly)
Advance	Customizable plans	• $25(Monthly) • $20(Yearly)
Enterprise	Customizable plans	Customizable solutions

What if the data center of the cloud service provider collapses or gets destroyed, would the user data also be destroyed? The answer is no. The cloud storage depends on hundreds of data centers, so even if one of the data centers collapses, there are hundreds of centers that would help you to retrieve and save your data.

This article is not about the nitty-gritty of cloud storage. This article focuses on the top 10 cloud storage services of 2020. There are many competitors in this field. Since all the big tech giants have their own cloud storage services, the competition is fierce. So, when we select a cloud storage service, we should consider some essential features such as service security, privacy, mobile app, pricing, complexity, and speed.

10 CLOUD STORAGE SERVICES

- DropBox
- iCloud
- Google Drive
- Microsoft One Drive
- IDrive
- Mega
- Box
- pCloud
- Tresorit
- Amazon Drive

1. DROPBOX

Dropbox is of the best file cloud storage and file synchronization services, developed by American company dropbox.

\ **Pros of dropbox**

- Ideal for any sized organization, big or small.
- It does not have a data limit.
- Data storage plans vary from 2GB to unlimited storage space.
- Supported by multiple devices such as Windows, Mac OS, Linux, Android, iOS, and Windows phones.
- Store and share any file on this platform.
- It provides you with admin control, which is very easy to use.
- It focuses on the privacy and security of its customers.
- Easily manage files without downloading them with the web version.
- **Dropbox pricing**

Cons of Dropbox

- Though it gives 30 days free trial but does not provide any free storage space.
- Very expensive for freelancers and sole users.

2. ICLOUD

Apple Inc. provides this cloud storage service and every apple user is aware of this technology. It is only available for Apple devices, and in Windows 7 or later versions, there is no mobile application for Android devices. iCloud serves more than 850 million active users.
With iCloud, you can store your data such as documents, music, pictures, etc. at the remote server of Apple data centers. It also stores data of other Apple apps such as mail, calendar, contact, Reminder, Safari, etc.

iCloud pricing
iCloud pricing varies from country to country:
United States (USD)

- 50GB: $0.99
- 200GB: $2.99
- 2TB: $9.99
- *India (INR)*
- 50GB: Rs 75
- 200GB: Rs 219
- 2TB: Rs 749
- **Cons of iCloud**
- Only People having an Apple ID can use this service.
- There is no Android App for this service
- Some of the app's data can only be transferred from one Apple device to another Apple device.

3. Google Drive
Google itself developed Google drive. With android devices, it comes with built-in integration.
Pros of Google Drive

- It can collaborate with many other services.
- Only accessible cloud storage service that provides 15GB of free space to its every user.
- Very easy to use.
- There are mobile and desktop apps for every operating system.
- It can be synced with any device.
- One of the best cloud storage services for big and small businesses.
- With Google drive, you can store any file.
- You can also integrate many third-party applications with Google Drive.

Google Drive pricing

Storage	**Price**
15GB	Free
100GB	$1.99 per month
200GB	$2.99 per month
2TB	$9.99 per month
10TB	$99.99 per month
20TB	$199.99 per month

30TB	$299.99 per month

Cons of Google Drive

- 5 TB data limit in Google Drive
- No password protection feature for shared files.
- The web interface of Google drive could be confusing.

4. MICROSOFT ONE DRIVE

Microsoft One Drive was specially designed for Microsoft users, so the documents of Microsoft application could be saved on the cloud storage.

Pros of Microsoft One Drive

- Considered one of the best cloud storage services for data management, project and workflow, user management, and branding.
- Provides mobile and desktop applications for all the popular operating systems such as Android, Windows, and Apple.
- 5 GB of free cloud storage to its user.
- Can be easily integrated with the Windows file explorer so you can quickly backup your data.

One Drive pricing

Plan	Plan Editions	Price	Storage
Personal	Personal	Free	5 GB
	Personal Unlimited	$9.95/month	Unlimited storage
	Custom	$5/month	500GB
Business	Custom	$7/month	500 GB
	Business Unlimited It provides Branding features.	$29.95/month	Unlimited
	Reseller Unlimited It comes with a partner account.	$59.95/month	Unlimited

Cons of One Drive

- Often compared with Google drive, and it provides less free space than Google.
- Limitation of the uploaded data file of 15GB.
- Does not have an easy to use interface.

5. IDRIVE

IDrive is a cloud storage service that mostly focuses on the data backup feature.

Pros of IDrive

- Highly recommended for freelancers and small organizations.
- Storage plans vary from 5 GB to 1.12TB.
- Supported by Windows, Mac, IOS, and Android.
- File size cannot exceed 2 GB.
- Only provides 5 GB of free space.
- If a file is deleted, it can be recovered within 30 days.
- It can be synced with any device.

IDrive Pricing

Plans	**Storage Capacity**	**Price**
Basic	5GB	Free
IDrive Personal	2TB	$104.25 for two years
	5TB	$149.25 for two years
IDrive Business (Unlimited users, Unlimited computers, and servers.)	250GB	$149.25 for two years
	500GB	$299.25 for two years
	1.25 TB	$749.25 for two years

Cons of IDrive

- It has a very confusing interface.
- Hard to use.
- Its software can slow down your system.

6. MEGA

Mega is a cloud storage and file hosting service offered by an Auckland based company known as Mega limited. It is the only top cloud storage service that provides 50Gb of free data storage.

Pros of Mega

- Provides mobile and desktop applications for Windows, Linux, Android, iOS, and macOS operating systems.
- Many popular web browsers even have a browser extension for Mega cloud storage.
- Well known for its security features, which provide end-to-end encryption of files before they are uploaded, so even the Mega limited company employees cannot access the data without the proper key.
- Serves more than 100 million registered users.

Mega pricing

Plans	**Storage**	**Price/Month**
Mega Free account.	50GB	Free
Mega Lite account	200GB	$4.99

Mega Pro I account	500GB	$9.99
Mega Pro II account.	2TB	$19.99
Mega Pro III account	4TB	$29.99

Mega Cons

Its web-interface is only supported by Chrome and Mozilla Firefox.

7. BOX

- Box is highly recommended for enterprise solutions and for small teams.

Pros of Box

- It comes with 10GB of free storage.
- Focus on the security and privacy of the customers.
- Can store any file.
- Integrates with G-suit, so any Google files can be stored and shared with Box.
- Access from any device.
- Easy to use.
- You can invite other Box users to view your files and easily share data.

Box pricing

Plans	Storage	Price
Individuals Plans	10GB Storage	Free
Personal Pro	100GB Storage	$10 per month
Business Plans Starter	100GB	$5 per user/month
Business	Unlimited	$15 per user/month
Pro	1TB Storage	$4250
Custom	Unlimited Storage	Contact Company.

Cons of Box

- Very expensive
- 5GB file size upload limitation.

8. PCLOUD

pCloud is specially designed to store large files, and it is often used for personal and small businesses. pCloud only provides two plans for storage space 10 and 100 GB.

Pros of pCloud

- Supported by every operating system, which includes Windows, Linux, iOS, Mac, and Android.
- No free storage service in pCloud.
- Provides TLS/SSL encryption for data security.
- Multiple file-sharing options.
- Pictures and videos from any social media platform can be stored in pCloud.
- Offers plans for a lifetime, which is missing in most of the cloud storage service providers.

pCloud Pricing

Plan	Storage	Price/month
Premium	500GB	$3.99
Premium Plus	2TB	$7.99

Cons of pCloud

- No free storage plan.

9. TRESORIT

Tresorit is a cloud storage service that emphasizes on data security and encryption, and it is an ideal cloud storage service for individuals and businesses.

Pros of Tresorit

- Provides end-to-end data encryption on shared files.
- Supported by Windows, Linux, Android, Mac, and iOS.
- Highly recommended for confidential data storage.
- Very secure. Tresorit encrypts every file before they are uploaded to the cloud, applying the Advanced Encryption Standard algorithm using 256-bit keys.

Tresorit pricing

Plan	Storage	Price/month
Small Business (2 Users)	1,000GB	$20
Big Business (10 Users)	1TB	$12
Enterprise (100 Users)	1 TB	$24

Cons of Tresorit

- Does not provide any free storage.

10. AMAZON DRIVE

- Amazon Drive was formerly known as Amazon Cloud Drive. Amazon itself supports it for the cloud storage service, file backup, file sharing, and photo printing.
- This cloud service is only limited to some countries which include, United States, United Kingdom, Japan, Germany, Spain, France, Italy, India, Australia, Canada, China, and Brazil.
- Provides unlimited free storage for Amazon Prime subscribers.

Amazon Drive pricing

Plans	Storage	Price/Month
Prime Membership	5GB	Free
100 GB Amazon Storage plan	100GB	$19.99
1 TB Amazon Storage Plan	1TB	$59.99

Cons of Amazon Drive

- Not for business use.
- A file size greater than 2GB won't be uploaded.
- Amazon Drive streaming is not available for videos longer than 20 minutes or larger than 2 GB
- Only for personal use.

DATABASE SERVICES:

Like SaaS, PaaS and IaaS of cloud computing we can consider DBaaS (also known as Managed Database Service) as a cloud computing service. It allows users associated with database activities to access and use a cloud database system without purchasing it.
DBaaS and cloud database comes under Software as a Service (SaaS) whose demand is growing so fast
In simple we can say Database as a Service (DBaaS) is self service/ on demand database consumption coupled with automation of operations. As we know cloud computing services are like pay per use so DBaaS also based on same payment structure like how much you will use just pay for your usage. This DBaaS provides same function as like standard traditional and relational database models. So using DBaaS, organizations can avoid data base configuration, management, upgradation and security.

DBaaS consists of an info manager element, that controls all underlying info instances via API. This API is accessible to the user through a management console, typically an online application, that the user might use to manage and assemble the info and even provision or deprovision info instances.

Key Characteristics of DBaaS :

- A fully managed info service helps to line up, manage, and administer your info within the cloud and conjointly offer services for hardware provisioning and Backup.
- DBaaS permits the availability of info's effortlessly to Database shoppers from numerous backgrounds and IT expertise.
- Provides on demand services.
- Supported the resources offered, it delivers a versatile info platform that tailors itself to the environment's current desires.
- A team of consultants at your disposal, endlessly watching the Databases.
- Automates info administration and watching.
- Leverages existing servers and storage.
-

How does DBaaS work :
It is a service that is added to our databases which make our daily tasks easier. It eliminates tedious and time-consuming administration tasks and makes our tasks simpler and more flexible. Now most of the organizations are going for DBaaS as it helps organizations to accelerate their business performance by starting their working with database more easily and running the workloads without delay.
Once we move our database to the cloud, we have the option to add software deployment as a service. Doing so simplifies the processes required to make information available through Internet-based communications. Storage consolidation can also be useful for moving company databases to the cloud.

Advantages of DBaaS :

1. DBaaS is responsible of the info supplier to manage and maintain info hardware and code.
2. The hefty power bills for ventilation and cooling bills to stay the servers running area unit eliminated.
3. An organization that subscribes to DBaaS is free from hiring info developers or constructing a info system in-house.
4. Make use of the most recent automation, straightforward outs of clouds area unit possible at low price and fewer time.
5. Human resources needed to manage the upkeep of the system is eliminated.
6. Since DBaaS is hosted off-site, the organization is free from the hassles of power or network failure.
7. Explore the portfolio of Oracle info as a service.

Disadvantages of DBaaS :

1. Traditional enterprises may have objections to cloud-based services generally.
2. In case of significant failure of the DBaaS server or network, the organization might lose its knowledge.
3. Companies already equipped with resources and IT-related human resources might not realize DBaaS solutions economically viable.
4. Intrinsic network connected problems with cloud can impact the performance of a DBaaS.
5. Features offered within the typical RDBMS might not perpetually be offered during a DBaaS system.
6. The use of DBaaS may result in revenue loss in alternative areas of code updates and hardware management.

EXAMPLES OF DATABASE SERVICES :

MICROSOFT AZURE

Microsoft Azure cloud database is one of the most popular and globally widespread cloud platforms. It offers computing, networking, databases, analytics, AI, and IoT services.
The public cloud computing platform from Microsoft offers various solutions, including Infrastructure as a Service (**IaaS**), Platform as a Service (**PaaS**), and Software as a Service (**SaaS**).

Microsoft Azure offers a wide range of software solutions that allow users to create a vast ecosystem with **the same base**, making any issues easy to resolve.
The downside is that Azure needs to be **expertly managed and maintained**, including patching and server monitoring.

Amazon Web Service (AWS)
AWS is one of the market leaders when it comes to DBaaS. Amazon offers various services for data management and integration. Some of AWS database solutions are:

- **Amazon RDS**. Amazon **R**elational **D**atabase **S**ervice runs on either Oracle, SQL, or MySQL server instances.
- **Amazon SimpleDB**. Designed for smaller workloads, SimpleDB is primarily a schema-less database.
- **Amazon DynamoDB**. DynamoDB is a NoSQL database capable of automatically replicating workloads across three availability zones.

The downside is that scaling and patching operations require **downtime**.

Oracle
Oracle offers enterprise-scale cloud database technology to its users. The database solution uses machine learning to **automate database management**, ensuring high performance, reliability, and security.
Oracle cloud database covers hyper-scale Big Data and Streaming workloads, including OLTP, data warehousing, Spark, text search, image analytics, and data catalog.
The different solutions offered are Infrastructure as a Service (**IaaS**), Platform as a Service (**PaaS**), Software as a Service (**SaaS**), and Data as a Service (**DaaS**).
The downside is a **lack of integration** with other cloud solutions.

Google Cloud
Google Cloud Platform (**GCP**) offers various services that use the same hardware and infrastructure as other Google products. GCP's offer includes a wide range of hosted services for cloud computing, storage, networking, big data, machine learning, IoT, cloud management, etc.
GCP provides **IaaS**, **PaaS**, and **serverless computing environments**.
One of the products in Google Cloud Platform is **Cloud Datastore**, a database storage solution for NoSQL non-relational storage.

Other Google Cloud products are **Cloud SQL** for MySQL fully relational storage and Google's native **Cloud Bigtable** database.
The downside is a **lack of managed services** and the **high prices**, including a costly support fee.

IBM Db2 on Cloud
IBM Db2 on Cloud is a fully managed SQL database featuring a **99.99% uptime SLA**, independent storage and compute scaling through UI and API, several disaster-recovery options, data encryption, and other features.
IBM's relational database offers **advanced data management** and analytic capabilities for transactional and warehousing workloads. This database delivers high performance, boasts great insights, data availability, reliability, and broad operating system support.
The downside of IBM Db2 is that it has **fewer regional options**, affecting performance in some cases.

MongoDB Atlas
MongoDB Atlas is a cloud database created and managed by the same team that developed MongoDB.
Mongo's cloud database is a fully managed NoSQL database that features flexibility, scaling, sharding, and **database management automation**. It allows most developers to go through various delivery models without requiring help from a database administrator.
The downside is that MongoDB Atlas is **NoSQL only**, which means that SQL-reliant applications are not an option with this database.

OpenStack
OpenStack is an open-source, highly customizable, and scalable cloud database with a **simple architecture and easy deployment**. The database is developed by the community and based on development milestones, with a release cycle of about six months.

Both **relational** and **non-relational** database engines are supported, while cloud users and DBAs can manage multiple database instances.
The downside is that OpenStack **requires expert engineering** skills to move along the numerous configuration options and resolve any potential issues.

DataStax Astra
DataStax Astra is a fully-managed scalable NoSQL cloud database **based on Apache Cassandra** as a platform, and it offers native, hybrid, and multi-cloud services.
Learn the difference between hybrid and multi-cloud in our comparison article.
DataStax's database solution is scalable, boasts data encryption and security, and allows deployment on AWS, GCP, and Azure.
The downside is that DataStax Astra supports **single-region deployments** only.

Rackspace
Rackspace offers scalable, fully managed, or hosted cloud databases, characterized by **high performance** and a storage area network (SAN) based on the OpenStack platform.
Rackspace offers easy access to your cloud database via Cloud Control Panel, CLI or API, and features regular backups of all cloud databases.

Redundant storage and **synchronous data replication** ensure data protection in case of disaster or hardware failure.
The downside is a **smaller number of data centers** compared to the competition.

Redis Enterprise Cloud
Redis Enterprise Cloud offers a NoSQL cloud database solution that features a five-nines availability (99.999%), excellent in-memory performance, and auto-scalability. Redis has global distribution across regions, clouds, or hybrid environments while maintaining sub-millisecond access time.
The provider performs **periodic data backups** and offers **auto-cluster recovery**, ensuring data security and cloud disaster recovery.
The downsides are a **not very user-friendly web UI** and requires **high expertise** for database management.

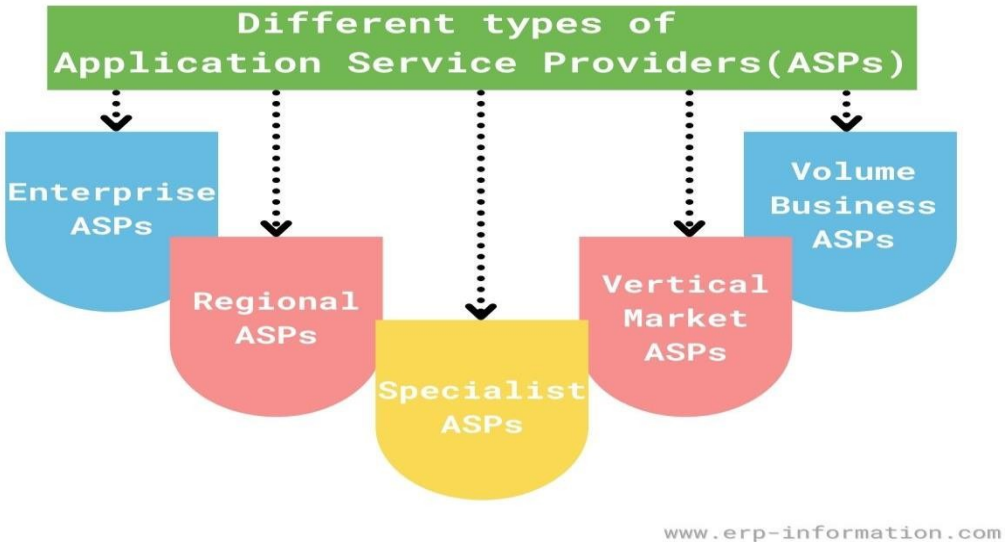
EDB Postgres Advanced Server
EnterpriseDB cloud database solution focuses on **PostgreSQL**, but it can also work on **Oracle database applications**, allowing users to easily migrate from Oracle.
EnterpriseDB features remote database administration services, including monitoring, managing, and maintaining Amazon RDS for PostgreSQL and Microsoft Azure Database for PostgreSQL. The provider also offers a Cloud DBA service for customers who need expert support for cloud-hosted Postgres.
The services include scheduled backups and binary replications for securing data.
The downside is that the **backup and recovery tools are not as good as Oracle's**.

SAP HANA Cloud
SAP HANA Cloud is a fully managed, scalable, in-memory cloud database as a service (DBaaS) solution. The database can be **deployed on the cloud** or in a hybrid environment.
The database solution provides high processing performance due to multi-model hybrid transactions. Users receive software patches regularly, the backups are automated, and there is no need to worry about required software installations.
The downside is that SAP HANA Cloud **requires experienced database engineers**, and the necessary cloud training is pricey.

Application Services :

General examples of the application software providers are the use of yahoo mail, Gmail, google sheets, and google docs. These are free ASP applications.
With the help of a web browser with necessary plug-ins, users can access yahoo mail hosted by Yahoo, google mail hosted by Google.
Other everyday use cases are credit card payment processing, accounting, and bookkeeping,
You're a small business owner who wants to find a better way to manage your accounting and bookkeeping.

Different kinds of ASP Services



Enterprise ASPs are designed for complex businesses to suit their intense requirements. As a result, the user interface is more comprehensive and has greater administrative power.

Regional ASPs are suitable for small businesses that cover small geographic locations. They can be a good choice for companies looking to expand but are still in their early stages.

Specialist ASPs cater to specific accounting, human resources, payroll, Customer Relationship Management, etc. These are ideal for businesses that operate within a particular niche and require specialized software to manage their tasks.

Vertical market ASPs are industry-specific and provide unique tools and features for specific niches, e.g., retail or healthcare industries.

Volume Business ASPs provide applications for which the customers pay in advance and are well aware of the services that fall in the brackets of the packages designed.

HP, SAP, and Qwest are leading enterprises that rent asp software.

ADVANTAGES OF ASP

- It allows you to reduce the cost of the organization.
- It Allows you to choose the modules with good processing abilities at a low cost.
- It helps to maintain software and hardware efficiently.
- It makes easy use of software for the organization through automatic software upgrades and technical support.
- It helps to reduce the load on hardware and human resources.

DISADVANTAGES OF ASP

- In a single occupant condition, applications acquired by one client are closed from the other customer's application. Hence costs will not reduce as they accept more customers.
- It offers virtual servers instead of dedicated servers for many customers. But unfortunately, that leads to security issues and data breaches.
- The business might be affected if the provider closes or goes bankrupt, as users depend on their servers and applications.
- They may not give the latest version updates, leading to a lack of security and features.

CONTENT DELIVERY SERVICES :

CLOUD CDN :

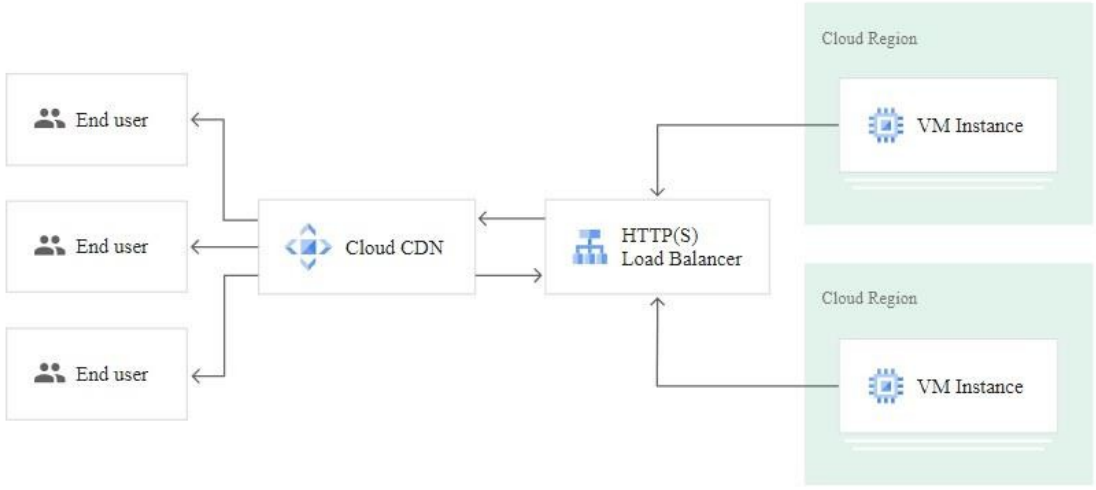
Cloud CDN (Content Delivery Network) uses Google's global edge network to serve content closer to users, which accelerates your websites and applications.

Cloud CDN works with the global external HTTP(S) load balancer or the global external HTTP(S) load balancer (classic) to deliver content to your users. The external HTTP(S) load balancer provides the frontend IP addresses and ports that receive requests and the backends that respond to the requests.

Cloud CDN content can be sourced from various types of backends:

- Instance groups
- Zonal network endpoint groups (NEGs)
- Serverless NEGs: One or more App Engine, Cloud Run, or Cloud Functions services
- Internet NEGs for external backends
- Buckets in Cloud Storage

In Cloud CDN, these backends are also called ***origin servers***. The following figure illustrates how responses from origin servers running on VM instances flow through an HTTP(S) load balancer before being delivered by Cloud CDN.



Cloud CDN response flow

How Cloud CDN works

When a user requests content from an external HTTP(S) load balancer, the request arrives at a Google Front End (GFE), which is at the edge of Google's network as close as possible to the user.
If the load balancer's URL map routes traffic to a backend service or backend bucket that has Cloud CDN configured, the GFE uses Cloud CDN.

Cache hits and cache misses

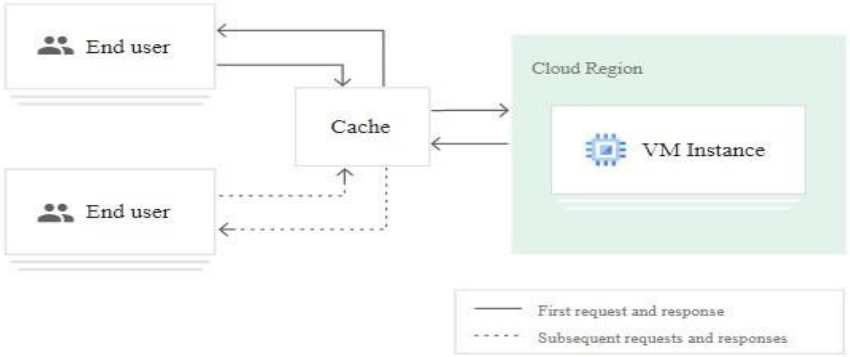
A cache is a group of servers that stores and manages content so that future requests for that content can be served faster. The cached content is a copy of cacheable content that is stored on origin servers.
If the GFE looks in the Cloud CDN cache and finds a cached response to the user's request, the GFE sends the cached response to the user. This is called a ***cache hit***. When a cache hit occurs, the GFE looks up the content by its cache key and responds directly to the user, shortening the round-trip time and saving the origin server from having to process the request.

A ***partial hit*** occurs when a request is served partially from cache and partially from a backend. This can happen if only part of the requested content is stored in a Cloud CDN cache, as described in Support for byte range requests.
The first time that a piece of content is requested, the GFE determines that it can't fulfill the request from the cache. This is called a ***cache miss***. When a cache miss occurs, the GFE forwards the request to the external HTTP(S) load balancer. The load balancer then forwards the request to one of your origin servers. When the cache receives the content, the GFE forwards the content to the user.

If the origin server's response to this request is cacheable, Cloud CDN stores the response in the Cloud CDN cache for future requests. Data transfer from a cache to a client is called ***cache egress***. Data transfer to a cache is called ***cache fill***.

The following figure shows a cache hit and a cache miss:

- Origin servers running on VM instances send HTTP(S) responses.
- The external HTTP(S) load balancer distributes the responses to Cloud CDN.
- Cloud CDN delivers the responses to end users.



Cache hit and cache miss

For costs related to cache hits and cache misses, see Pricing.

NO URL REDIRECTION

Cloud CDN doesn't perform any URL redirection. The Cloud CDN cache is located at the GFE. This means the following:

- Whether or not Cloud CDN is enabled, the URL that a client requests remains the same URL.
- Whether or not there's a cache hit, the URL remains the same URL.

CACHE HIT RATIO

The ***cache hit ratio*** is the percentage of times that a requested object is served from the cache. If the cache hit ratio is 60%, it means that the requested object is served from the cache 60% of the time and must be retrieved from the origin 40% of the time.

ANALYTICS SERVICES :

Cloud analytics services refers to a set of cloud-based solutions for businesses that helps them harness the power of the volumes of data they're collecting. It provides for a way to organize, manage and analyze data in a way that provides insights for making business decisions. In some cases a service might combine software tools with data storage in the cloud. In other cases, a business might create the software tools and use the data storage and computing power of cloud services to work on their data.

Like so many things today, the shift in storing, organizing and processing this data is toward a cloud environment, where components like data warehouses are flexible, scalable and more inexpensive than hosting data on site. And, even better, business owners can view and analyze data from any web browser anywhere in the world.
Taking advantage of this cloud-based solution requires a service provider that offers the resources and tools necessary for the consumer to sort through data and grab valuable insights.

SERVICE PROVIDERS

There are many Cloud Analytics offerings available to business owners. Some offer a complete suite of software and hardware that require little work by the owner. Other offerings focus on providing the hardware required for storage and analysis, but the business owner provides both the data and software.

DEPLOYMENT SERVICES :

Cloud deployment is the process of deploying an application through one or more hosting models—software as a service (SaaS), platform as a service (PaaS) and/or infrastructure as a service (IaaS)—that leverage the cloud. This includes architecting, planning, implementing and operating workloads on cloud

benefits of cloud deployment:

With an effective cloud deployment model, an organization achieves numerous benefits, including:

- **Faster and simplified deployments.** Automate builds that deploy code, databases and application releases, including resource provisioning.
- **Cost savings.** Control costs using consumption-based pricing and eliminate capex-heavy on-premises environments.
- **Platform for growth.** Leverage the global infrastructure provided by cloud service providers (CSPs) to seamlessly expand the business into other geographies.
- **New digital business models.** Exploit the continuous release of features and services by CSPs, incubate new technologies and innovate digital business models.
- **Business resiliency.** Architect for the availability and fault-tolerance CSPs offer and ensure disaster recovery and business continuity of applications to make the business resilient.
- **Agility and scalability.** Use autoscaling and scalability to meet peak demands of the business without provisioning for excess capacity.
- **Geographic reach.** Access applications from any location, on any device, leveraging the connectivity backbone of CSPs.
- **Operational efficiency.** Use the inherent automation enabled by cloud to increase operational efficiency and reduce human effort.
- **A competitive edge.** Leverage infrastructure as code and development, security and operations (DevSecOps) to reduce the time to market for new features and stay ahead of the competition.
- **Empowered users.** Increase productivity by empowering users with self-service options on cloud, such as portals, DevOps pipelines and executive and operational dashboards.

Deploying applications to the cloud?

Some key challenges when migrating applications range from high CapEx for hosting infrastructure to slower deployments, complex and costly migrations, insufficient monitoring methodologies, complex system integrations, dynamic and seasonal workloads, lock-in periods for infrastructure hosting and with application vulnerabilities.
To address these challenges, look for the following in a cloud services provider:

- A cost-saving pay-per-use model
- Rapid provisioning of systems
- Best-in-class technical operations
- Self-services for non-production systems
- Transparent metering and resource inspection
- High-availability solutions integrated with software-as-a-service options, auto-scaling, infrastructure flexibility and portability
- Managed cloud platform security
- A robust **cloud management** platform.

Management Services:

Cloud management is the organized oversight, control, administration and maintenance of public cloud, private cloud, or more commonly, hybrid (public and private) multi-cloud computing infrastructure, services, and resources. It gives IT teams a firm hold over scalable and dynamic cloud computing environments. Cloud management services combine different technologies and products to deliver a cohesive, consistent strategy and process. Administrators can orchestrate delivery and management of cloud infrastructure, applications, data, services and access control. They can access resources, automate processes, make changes as needed, and monitor utilization and cost.

Organizations are increasingly deploying enterprise applications to the cloud in order to reduce the high upfront investments they would otherwise have to make for on-site infrastructure. Public cloud environments provide on-demand computing power and data storage that is consistent with the growing, fluctuating demand for data and services. Through cloud service management, administrators oversee cloud activities ranging from resource deployment and utilization, to lifecycle management of resources, data integration and disaster recovery.

HOW DOES CLOUD MANAGEMENT WORK?

Cloud management is a discipline but one that is facilitated by tools and software. To realize the control and visibility required for efficient cloud management, enterprises should see their hybrid IT infrastructure through a consolidated platform that pulls relevant data from all the organization's cloud-based and traditional on-premises systems.

Cloud management platforms help IT teams secure and optimize cloud infrastructure, including the applications and data residing on it. Administrators can manage compliance, set up real-time monitoring, and preempt cyberattacks and data breaches.

So how does it work? Typically, a cloud management system will be installed on the target cloud. It captures information on activity and performance then sends analysis to a web-based dashboard where administrators can see and act accordingly. Where there is an issue, administrators can issue commands back to the cloud through the cloud management platform, that servers as a consolidated point of control.

BENEFITS OF CLOUD MANAGEMENT

PERVASIVE AUTOMATION

Cloud application management eliminates manual intervention from routine tasks and workflows by automating resource provisioning and maintenance through models or blueprints. Business policies are transformed into virtual steps that are then configured into the cloud management platform. Provision cloud infrastructure and enterprise application resources based on pre-defined permissions and policies.

Cloud management software can detect problems, resolve them, generate reports and send notifications to administrators, all without human intervention. Automation reduces errors while improving efficiency.

CUSTOM, BUSINESS TAILORED IT SERVICES

Cloud management allows IT to customize cloud services for specific requirements. Design blueprints – IT services – which can be simple applications or complex full-stack environments for your developers. Some cloud management solutions enable modularity, where a single design can be reused to automate the fulfillment of a wide variety of requests - by simply selecting service options or parameters into the fulfillment process. Scripts can be composable, which means you can just as easily remove parts of particular scripts or flows as you can add to them. Making the service customization experience much easier.

IDENTITY AND ACCESS MANAGEMENT SERVICES :

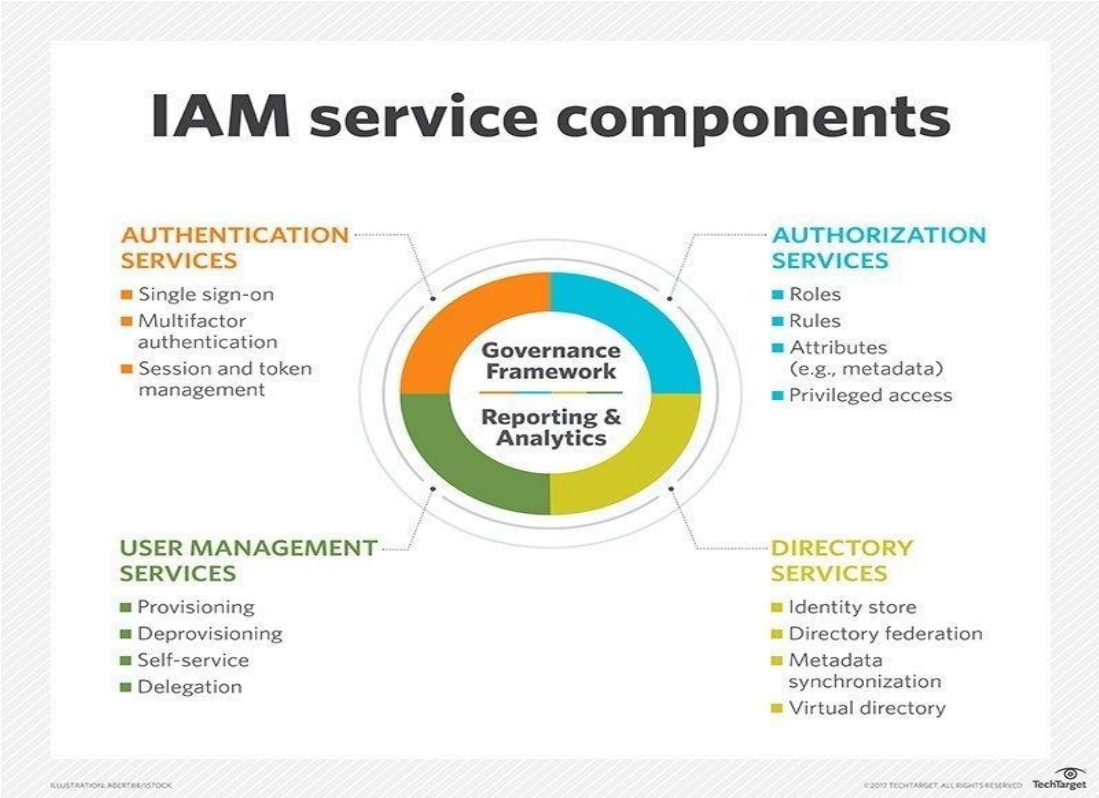
Identity and access management (IAM) is a framework of business processes, policies and technologies that makes it easier for organizations to manage electronic or digital identities. IAM frameworks enable IT managers to control user access to critical information within their companies.

IAM tools offer role-based access control to allow system administrators to regulate access to systems or networks based on the roles of individual users within the organization. Creating effective IAM policies, such as a privacy policy, protects data privacy by limiting user access to resources and protects against unauthorized access.

IAM technologies include password-management tools, single sign-on systems (SSO), two-factor authentication, multifactor authentication (MFA), privileged access management (PAM) and privileged identity management (PIM). These tools let organizations securely store identity and profile data, as well as data governance functions, to ensure that only necessary and relevant data is shared.

IAM ensures greater control of user access. By identifying, authenticating and authorizing users, as well as prohibiting unauthorized users, IAM security boosts the efficiency and effectiveness of access management across an organization.

Identity management systems can be deployed on premises, provided by a third-party identity provider through a cloud-based subscription model or deployed in a hybrid model.



1. Enhances Data Security

Controlling user access allows organizations to eliminate instances of identity theft, data breaches and illegal access to sensitive corporate information. IAM can prevent the dissemination of compromised login credentials, prevent unauthorized access to a company's network as well as protect against hacking, ransomware, phishing and other types of cyberattacks.

2. Streamlines IT Workload

When a security policy gets updated, all access privileges across an enterprise can be changed at one time. IAM can also help cut down on the number of tickets employees send to the IT helpdesk for password resets.

3. Helps in Regulatory Compliance

IAM can help organizations meet the requirements of industry regulations to ensure the security and privacy of customer data, such as the Health Insurance Portability and Accountability Act (HIPAA), Sarbanes-Oxley (SOX) and the Payment Card Industry Data Security Standard (PCI-DSS)

4. Reduces Human Error

With an identity and access management tool in place, companies can eliminate manual account and permission errors because the IT department no longer has to manually manage access rights to data. In addition, IT no longer has to deal with careless employees who may make mistakes that can result in costly fines.

5. More Effective Access to Resources

Users who receive access through a centralized platform benefit from using SSO technology as it limits the number of interactions they have with security systems and increases the probability that they will succeed in their legitimate attempts to access resources.

6. Confidentiality of Data

By restricting access for those who don't need to use certain apps or files, organizations can better secure sensitive data as well as enable project managers to have a clearer picture of which users are associated with which projects.

7. Helps Manage Access Across Browsers and Devices

One benefit of cloud applications is that users can access them from any device that's connected to the internet. However, the downside is that more applications means more URLs and passwords. In addition, the increase in mobile devices means that IT administrators must manage and support another access point.

Cloud-based IAM tools can provide browser-based SSO to all user application as well as enable access to those same services from users' mobile devices.

Open Source Private Cloud Software :

Private cloud is a cloud computing environment dedicated to a single customer. It combines many of the benefits of cloud computing with the security and control of on-premises IT infrastructure.

How private cloud works

Private cloud is a ***single-tenant*** environment, meaning all resources are accessible to one customer only—this is referred to as ***isolated access***. Private clouds are typically hosted on-premises in the customer's data center. But, private clouds can also be hosted on an independent cloud provider's infrastructure or built on rented infrastructure housed in an offsite data center. Management models also vary—the customer can manage everything itself or outsource partial or full management to a service provider.

Private cloud architecture

Single-tenant design aside, private cloud is based on the same technologies as other clouds—technologies that enable the customer to provision and configure virtual servers and computing resources on demand in order to quickly and easily (or even automatically) scale in response to spikes in usage and traffic, to implement redundancy for high availability, and to optimize utilization of resources overall.

These technologies include the following:

- **Virtualization,** which enables IT resources to be abstracted from their underlying physical hardware and pooled into unbounded resource pools of computing, storage, memory, and networking capacity that can then portioned among multiple virtual machines (VMs), containers, or other virtualized IT infrastructure elements. By removing the constraints of physical hardware, virtualization enables maximum utilization of hardware, allows hardware to be shared efficiently across multiple users and applications, and makes possible the scalability, agility, and elasticity of the cloud.
- **Management software** gives administrators centralized control over the infrastructure and applications running on it. This makes it possible to optimize security, availability, and resource utilization in the private cloud environment.
- **Automation** speeds tasks—such as server provisioning and integrations—that would otherwise need to be performed manually and repeatedly. Automation reduces the need for human intervention, making self-service resource delivery possible.

In addition, private cloud users can adopt cloud native application architectures and practices—such as DevOps, containers, and microservices—that can bring even greater efficiency and flexibility and enable a smooth transition to a public cloud or ***hybrid cloud*** environment in the future.

OPEN SOURCE CLOUD SOFTWARE AND SOLUTIONS LIST:

- **Open Stack**
- **Cloud Stack**
- **Apache Mesos**
- **Eucalyptus**
- **Open Nebula**
- **AppScale**

1. OPEN STACK

Open stack is a lot of open source cloud software programming contraptions for regulating distributed computing stages for public and private clouds. This programming stage is contained interrelated parts that control grouped, multi-dealer hardware pools of taking care of, amassing, and frameworks organization resources all through a server

farm. Open Stack could be regulated through an electronic dashboard, through request line instruments, or through peaceful web organizations.

Key Highlights of Open Stack:

• Limitless accumulating: Tremendous and level namespace, incredibly versatile read/make access, prepared to serve substance clearly from the limit structure.

• Multi-dimensional adaptability: cale-out designing: It scales vertically and equitably scattered limit. It can back up and chronicles a ton of data with straight execution.

• Record/holder: No settling, not a standard record system. It scales to various petabytes just as billions of articles.

2. CLOUD STACK

Cloud stack is an open source cloud software platform expected to pass on and administer immense associations of the virtual machine, as a significantly available, especially adaptable establishment as an assistance distributed computing. It's a java-based undertaking that gives an organization labourer, and trained professionals (if essential) for hypervisor has so you can likewise run an iaas cloud. Cloud stack as of now reinforces the most well-known hypervisors: VMware, kvm, citric XenServer, xen cloud Stage (XCP), Prophet VM specialist and MS Hyper-v.

Key Highlights of Cloud stack:

• Works with have running xen worker, kvm, Hyper-v, just as VMware esxi with vsphere .

• Gives an agreeable Electronic UI to managing the cloud.

• Gives a nearby Programming interface. Customers can bargain their cloud with an easy to use Web interface, request line mechanical assemblies, or conceivably a full-included Serene Programming interface.

3. APACHE MESOS

Apache mesos is a complete open-source solution that handles occupations capably in a passed on the environment through ground-breaking resource sharing just as disconnection. It dynamic PC processor, memory, storing, and other register resources from machines, enabling issue liberal and adaptable appropriated structures to be helpfully built and run sufficiently.

Features of Mesos

• Mesos is a cross-stage: It runs on Linux, osx and Windows. It is a Cloud provider freethinker all the while.

• Local assistance for dispatching compartments with Docker and appc pictures.

• Accomplishes staggering levels of High Availability: Issue tolerant repeated master and experts using Creature controller. Non-hazardous updates.

4. EUCALYPTUS

Eucalyptus is an open source cloud software storage for building aws-feasible private and hybrid clouds. It is a Linux based programming designing that executes versatile private and cross variety cloud inside your present IT establishment. As and on-premise System as a Help cloud game plan, it licenses you to use your own collections of resources (hardware, storing, and association) using a self-organization interface subordinate upon the circumstance.

Key Highlights of Eucalyptus:

• Design of Eucalyptus is awes Practical and appropriately has five key parts, Cloud controller, Walrus, Pack controller, Accumulating controller, Center controller and Euca2ool.

• Clients can likewise run Amazon or Eucalyptus machine pictures as events on both the cloud.

• Since it is aws suitable, there is 100% AWS Programming interface similitude ans maintain.

5. OPEN NEBULA

Open nebula is clear yet mind boggling and versatile turnkey open source answer for manufacture Private Cloud and regulate Worker ranch virtualization. It completes IaaS. The chief open-source variation of Open nebula was conveyed in Walk 2008.

Key Highlights of Open cloud:

• Fine-grained upper leg ligaments for resource task.

• Asset Offer the chiefs to follow and confine figuring, amassing and frameworks organization resource utilization

• Dynamic creation of Bundles as pool of hosts that shares information stores and virtual associations for load changing, high availability, and prevalent enrolling.

6. APPSCALE

Appscale is an open source cloud software distributed computing stage that thus passes on and scales unmodified Google Application Engine applications over open and private fog systems. It's a circled programming system that completes a cloud stage as assistance (PaaS). In light of everything, AppScale is an easy to-regulate worker less stage for building and for running flexible web and versatile applications on any establishment. The objective of Appscale is to give designers a quick, programming interface driven improvement stages that can run application on any cloud foundation.

Highlights of AppScale:

• Snappy prototyping

• AppScale isn't hard to use hence making associations favour it.

Characteristics of the open source cloud

The open source cloud has the following characteristics:

- No vendor lock-in and there is seamless integration of the enterprise applications, products and systems developed/deployed by different organisations and vendors.
- The source code will be made available for the community, for adopters and end users to study and modify the software and to redistribute copies of either the original or the modified version. Source code will also be free from any royalty.
- With no vendor monopoly, the use of free and open standards is possible. With data transferability and open data formats, there are greater opportunities to share data across interoperable platforms.
- Adoption of open source software enhances the interoperability with other enterprise solutions because the reuse of recommended software stacks, libraries and components is possible.