

Introduction to Cloud Computing



What is Cloud Computing?



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According to Wikipedia; "The term cloud is used as a metaphor for the Internet, based on the cloud drawing used in the past to represent the telephone network, and later to depict the Internet in computer network diagrams as an abstraction of the underlying infrastructure it represents." So, the Cloud term refers to software and services running on the Internet, not locally on your computer



There is no Cloud

Cloud computing, often referred to as simply the "cloud", means storing and accessing data and programs over the Internet rather than the hard drive of your computer. The data can be anything such as files, images, documents, and more.

Most cloud services are accessible through a web browser, such as Google Chrome or Firefox, and some companies offer custom mobile applications. Some well-known examples of cloud services include Google Drive, Netflix, Apple iCloud, Dropbox, and Microsoft

Why Cloud Computing?

Cloud Computing evolved the ways we use a computer.

- From companies to private users, everybody relies on the cloud directly or indirectly most of the time in their daily lives.
- Nowadays, cloud-based activities are rising the Internet's capacity more than ever before. So, nearly everything in the digital world runs on cloud computing.
- It increases the value of the work and promises to reduce costs and helps users focus on their business and work rather than IT obstacles.
- It offers flexibility, data recovery, little or no maintenance, easy access and a higher level of security.



Some industries leveraging Cloud Computing are ;

- IT
- Entertainment
- Marketing and Advertising
- Artificial Intelligence & Big Data
- Biotechnology and Pharmaceuticals
- Banking
- Education
- Healthcare
- Retail
- Automotive
- Manufacturing
- Financial
- Production
- Real Estate

How Cloud Works?

Information and data are stored on physical or virtual servers that a cloud computing service such as Amazon and it's AWS company retain and monitor. As a user of personal or business cloud computing, you use an internet connection to access the stored information on the cloud.

Advantages of The Cloud Technology

There are various benefits of cloud computing technology. The most important ones are given below.



Cost Efficiency

- One of the most important benefits of Cloud Computing is its economy.
- Cloud computing helps to reduce a significant amount of expenditure on both capital & operational manner.
- You do not need to invest in expensive hardware, storage devices, and software, and only pay for the services you use. This also saves the infrastructure costs and the money needed to manage the network.
- It provides the companies with the lowest possible level of operation with zero data capacity and software requirements, the business can save significant capital costs.



Elasticity & Flexibility

- Cloud computing helps you to reduce your resource demands and increase them according to your needs.
- For example, you can increase your resources if you have heavy traffic on your site and vice versa.
- Cloud computing gives you the flexibility to work anywhere you want, and all you need is an internet connection whenever you want.



Reliability

- Cloud computing is very reliable as the stored data is secured and can not be manipulated.
- Several copies of the data are being made, and if the database fails, the data from the other side can be recovered.
- The company can take advantage of both the vast pool of redundant IT services and the process of failover.



Increased Security

- Everything you access and save with cloud computing is on the cloud. The providers of the service pick the highest level of data protection.
- Even if a laptop is lost or damaged, another computer can be used to access the company GUI. And since all of the records are stored on the cloud, there is no question about losing important documents because they have been saved on a hard drive laptop that is now lost or damaged.
- The full-time job of a cloud host is to track security carefully, which is significantly more efficient than a traditional in-house program, where an organization needs to divide its efforts among a multitude of IT issues, with security being just one of them.



Manageability

- Cloud computing provides improved and streamlined capabilities for IT management and maintenance by central resource management.
- Many items are handled by cloud computing. The only thing the user has to do is get an internet connection and a laptop.



Availability

- By its definition, cloud computing depends on the Internet, ensuring that businesses interested in starting or extending their use of cloud-based services need to work closely with an IT consulting firm to show them how to manage bandwidth rates that will be sufficient to meet their IT needs.
- Cloud service providers offer up to 99.99% uptime to ensure that business operations and executions continue to flow.



Centralization

- All data are stored in one location.
- So that multiple remote locations can be reached.



Auto-Updating

- Software updates and enhancements can be a painful thing that cloud computing simplifies for you.
- The cloud service provider looks after and controls all software maintenance and upgrades.



No Maintenance

- Organizations need to think about managing the entire system while operating a conventional server setup.
- A cloud computing solution eliminates the need for any maintenance.
- Not only does it increase work efficiency, but also reduces costs of operations in the longer run.

Disadvantages of The Cloud Technology

The drawbacks of cloud computing are as follows:



Internet Dependency

- Cloud computing requires internet connectivity as if you will not be able to access the cloud if there is no internet connection.
- There is no other way to access the data in the cloud.
- Similarly, a low-speed Internet connection makes cloud computing difficult and often impossible.



Downtime

- Cloud providers may face power loss, low internet connectivity, service maintenance, etc.
- A cloud outage is a period when cloud services are not available.
- So downtime or outage should also be considered while working with cloud computing.



Loss of Control

- Since cloud computing is very secure, it still requires attention.
- In essence, you trust another party to take care of your data.
- Once you accept cloud technology, you should be well aware that you will share all the sensitive information about your business with a third-party cloud computing service provider.

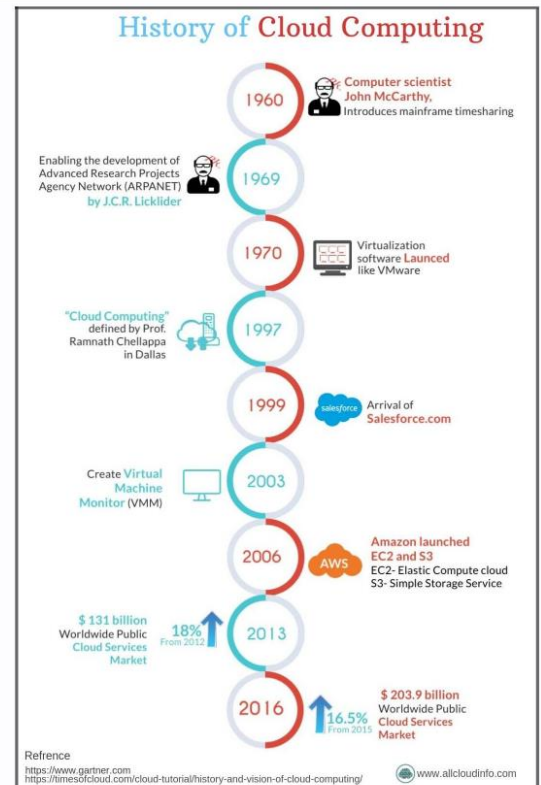


Lack of Support

- Cloud computing companies sometimes fail to provide customers with adequate support.
- If you have any technical problems, you have no choice but to call the technical support of your host provider for assistance.
- You can't fix the cloud computing problems, and some companies don't provide technical support around the clock.

Evolution of the Cloud Computing

When we think of cloud computing, we mostly look into the ideas and products we see in all-around and think that Cloud is all about the 21st century. But, in fact, Cloud concepts have existed long times ago, nearly the middle of the last century. Let's take a short tour around this period and try to understand the birth and evolution of Cloud computing.



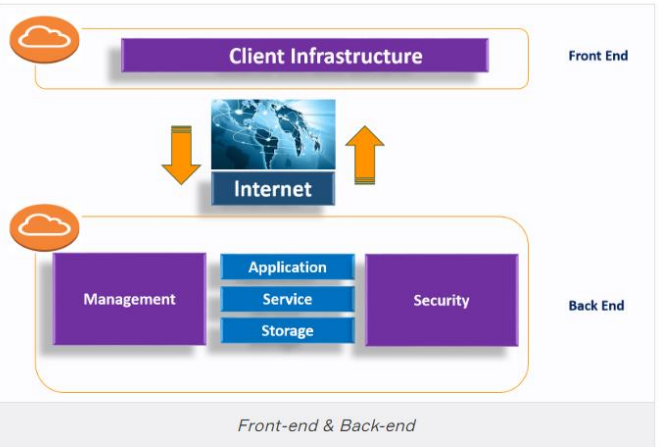
Historical Timeline of Cloud Computing

- The idea of cloud computing came into the picture in 1950 with accessible via thin/static customers and mainframe computer implementation.
- In 1959, Computer scientist John McCarthy initiates the first project to use a time-sharing system, which allows several people to use a single, central, computer at the same time.
- In 1969, J. C. R. Licklider, both a psychologist and a computer scientist, helped develop the ARPANET (Advanced Research Projects Agency Network), a "very" primitive version of the Internet. His vision was for everyone to be interconnected and accessing programs and data at any site like today's cloud computing.
- In 1970, the concept of virtualization has evolved with the Internet.
- In 1997, Professor Ramnath Chellappa from Emory University had mentioned the cloud in an article.
- In 1999, one of the first landmarks in the history of cloud computing was Salesforce.com's introduction of the idea of providing business applications through a single website.
- Amazon Web Services (AWS), which launched its public cloud in 2002, recognized the start of the modern-day cloud. At this point, there were virtually no competitors and while the advantages of using the cloud, such as elasticity and scalability, were recognized, the practical use cases were not yet available to persuade potential users.

- In 2006, Amazon launched Amazon Web Service (AWS) on a utility computing basis although the initial release dated back to July 2002. The most well-known of these services are Amazon EC2 and Amazon S3.
- In 2008, NASA's OpenNebula, enhanced in the RESERVOIR European Commission-funded project, became the first open-source software for deploying private and hybrid clouds, and for the federation of clouds.
- In April 2008, Google announced a preview release of App Engine, a developer tool that allowed users to run their web applications on Google infrastructure.
- In October 2008, Microsoft launched Azure.
- In 2011, IBM introduced the IBM SmartCloud framework, in support of Smarter Planet (a cultural thinking project). Then, Apple launched the iCloud, which focuses on storing more personal information (photos, music, videos, etc.).
- In 2012, Oracle launched the Oracle Cloud offering three business basics: IaaS (as-a-service infrastructure), PaaS (as-a-service platform) and SAAS (as-a-service software).

Parts of Cloud Computing Architecture

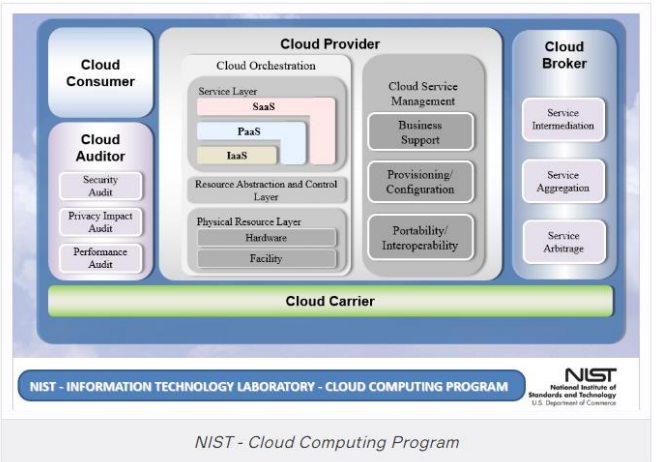
Cloud Computing architecture basically comprises of the two parts which are called Front-end and Back-end. Each of the ends is connected through a network, called Internet. The diagram below illustrates the architecture of the cloud computing:



- The **Front-end** is the client part of Cloud Computing.
 - The front end is the end which is used by the user.
 - It includes the user interface and applications which are required to access the cloud computing platforms.
 - Example: Web Browsers.
- The **Back-end** refers to the cloud itself.
 - The Back-end is managed by the host.
 - It consists of all resources which are necessary to provide cloud computing services such as virtual machines, data storage, deployment models, services models, security system, etc.
 - Providing built-in security mechanisms, traffic control and protocols is the responsibility of the Back-end.

Actor/Role Based Model

The following diagram by NIST shows the graphical view of cloud computing architecture actors in an actor/role-based model and the necessary architectural components for managing and providing cloud services such as service deployment, service orchestration, cloud service management, security, and data privacy.

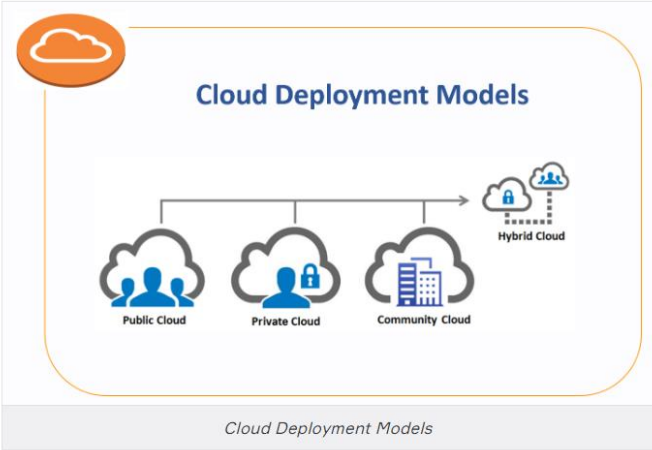


- A **Cloud Consumer** is an individual or organization that acquires and uses cloud products and services.
- The purveyor of products and services is the **Cloud Provider**.
- The **Cloud Broker** acts as the intermediate between consumer and provider and will help consumers through the complexity of cloud service offerings and may also create value-added cloud services as well.
- The **Cloud Auditor** provides a valuable inherent function for the government by conducting the independent performance and security monitoring of cloud services.
- The **Cloud Carrier** is the organization that has the responsibility of transferring the data akin to the power distributor for the electric grid.

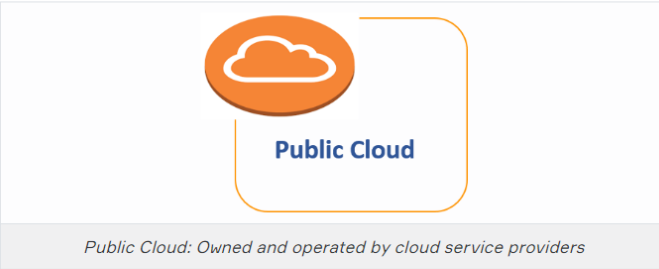
Deployment Models

Cloud Deployment Models

A cloud deployment model is a specific type of cloud environment, characterized primarily by ownership, scale, and access. Each deployment model is also defined by the location of the environment's infrastructure. There are four common cloud deployment models:



Public Cloud



Public Cloud is the name of the information service used for platforms that transfer data to all individuals or organizations with internet access.

- It is a form of computing in which a service provider offers services through the internet to the public.
- Resources vary by provider, but may include storage, device, or virtual machine capabilities.
- Public cloud allows for scalability and resource sharing that would not otherwise be possible for a single organization to achieve.
- Infrastructure-ready virtualized processor, memory, hard disk and storage areas, etc. resources are available, users' systems are created and run using these resources.
- Users do not need to purchase or update additional hardware or software.

Examples of Public Cloud Services:

- Amazon Elastic Compute Cloud (EC2)
- Google AppEngine
- Windows Azure Services Platform
- IBM Blue Cloud

Advantages of Public Cloud:

- Moving to an actual cloud infrastructure and using latest technologies
- Renting resources or applications at more reasonable prices
- Achieving high uptime through the use of reliable infrastructure, and having opportunities to work on infrastructure that has taken extra and unprecedented security precautions

Private Cloud



Private Cloud

Private Cloud: Owned and operated by your IT team

Private Cloud is a cloud computing service created by sharing virtualized resources with other parties or approved participants with whom they operate under the control of the individual, business or group. It provides the same Public Cloud benefits but uses private hardware dedicated to it.

- It means using a cloud infrastructure (network) solely by one customer/organization.
- It is not shared with others, yet it is remotely located.
- In the cloud system, all data circulates, is inaccessible to public internet access.
- The system itself and limited access are configured by itself or by the service provider according to the conditions set by the user.
- Taking full advantage of the cloud infrastructure, Private Cloud provides greater control and security of resources.
- The security and control level is highest while using a private network.

An example of a private cloud deployment is where you maintain your own servers and infrastructure that hosts your applications and data. The key difference between private and public clouds is that you are not responsible for managing a public cloud hosting solution. A large company may select a private cloud, while a smaller company may select a public cloud.

Advantages of Private Cloud:

- It can be installed anyway and anywhere as you wish
- Prevents data loss with data storage system
- Reduces costs

Community Cloud



Community Cloud

Community Cloud: Multi-company shared use of cloud technology

Community cloud means a shared platform, usually with shared data and data management considerations, between organizations.

- Although different companies do not choose this privacy and security cloud technology, it can be provided to people/organizations with more than one company to that of the intercompany data network.
- It is best suited to companies, business organizations, research organizations, and tenders.
- This helps group cloud users in first understanding and evaluating the market need.
- A community cloud, for example, may belong to a single country government and can be used by different departments of that government.
- It is possible to identify community clouds on and off the premises.

Like the private cloud solution, the community cloud has areas where it can greatly benefit agencies, but it's also not the right solution in all circumstances.

Advantages of Community Cloud:

- Ability to easily share and collaborate
- Lower cost

Hybrid Cloud



Hybrid Cloud

Hybrid Cloud: Integrated environment of public and private infrastructure

Hybrid cloud means using both private and public clouds, depending on their purpose.

- It is a cloud technology used in situations where security and privacy are fundamental and require precautions.
- The non-critical activities are carried out using the public cloud, while the critical actions are carried out using a private cloud.
- For example, it can be used to interact with customers while retaining secure data via a private cloud.

Some hybrid clouds offer only a connection between the on-premise and public clouds. More and more businesses are moving to a managed hybrid cloud model that will mix and match dedicated infrastructure, private cloud systems, and public cloud resources to meet their unique needs.

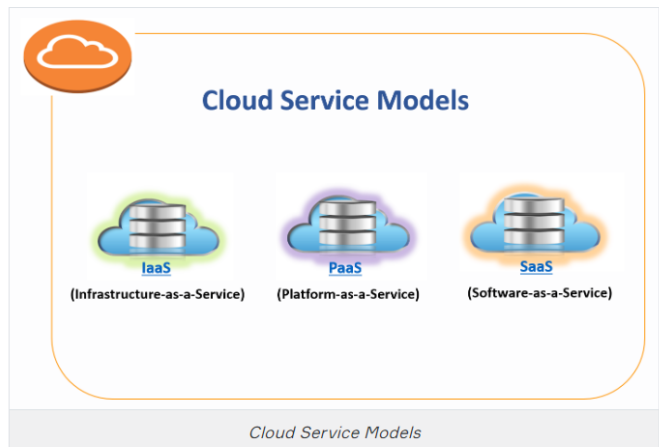
Advantages of Hybrid Cloud:

- The main advantage of a hybrid cloud model is control on the cloud .
- A hybrid cloud's scalability makes it an attractive alternative to a purely private cloud that can be incredibly expensive over time to upgrade and extend.
- Businesses can combine private cloud protection with public cloud resources and services.

Service Models

Cloud Service Models

When you look more deeply into what resources a cloud architecture can provide, you start talking about models of cloud service. Cloud Computing technology basically offers a variety of service-based model. Cloud Service Models are all about how a cloud provider provides its services to customers. and the scope of customers' needs. There are three basic service models:



Now, let's examine these models one by one. But firstly, we will take a short look at the On-Premise term.

On-Premise

On-Premise is a server-based software. Because it is server based, it means that all archives and data are displayed on the server source and not transferred to the internet environment.



- It is installed and runs on computers on the premises of the person or organization using the software, rather than at a remote facility such as a server farm or cloud.
- You are responsible for all the layers in the part where your software is installed on your or your company's computers.
- You must have a system team. This system team needs to know and set up servers, databases, security, network.
- It is necessary to make backups of the database and to install the current versions of the operating system.

IaaS - Infrastructure as a Service

IaaS, previously known as Hardware as a Service (HaaS), is a model based on a cloud computing platform. It's Cloud Computing's most basic service and the instant computing infrastructure which serves, manages, and monitors over the internet. For IaaS, a virtual server is built and users are equipped for cloud service.



IaaS - Infrastructure as a Service

- Customers outsource their IT infrastructure including servers, networking, distribution, storage, virtual machines, and other tools.
- The complete management is done by the Cloud Service provider.
- The installation, configuration, and management of the software are complete by the customer.
- Customers access these services on an Internet-based pay-per-use model, i.e. cloud computing network.
- It provides all computing resources but in a virtual environment so that multiple users can access them.
- The resources used can be increased/decreased at any time by taking advantage of the flexible structure of Cloud Computing.

Tip: When to Use IaaS

- IaaS supports companies of all shapes and sizes as it enables full control of your infrastructure and works on a pay-as-you-use model, making it ideal for most budgets.

PaaS - Platform as a Service

PaaS is a development framework for developers that is designed to create, test, run and manage applications for the programmer. A developer can easily write and deploy the application directly into this service.



PaaS - Platform as a Service

- PaaS basically expands the IaaS layer by eliminating the virtual machine management problem.
- It not only includes server, storage, and networking but also database, tools, business services, and many more.
- PaaS helps developers of applications to build their projects by offering layers of hardware and software.
- This service includes system management, operating system, a framework for the programming language, database, etc.
- Because the service provider manages the system, you only manage applications and data.
- Some popular PaaS providers are AWS Elastic Beanstalk, Google App Engine, Microsoft Azure, etc.

Tip: When to Use PaaS

- PaaS is often the most cost-effective and time-effective way for a developer to create a unique application.

SaaS - Software as a Service

Software as a service (SaaS) is a software distribution model in which applications are managed by a third-party provider and made available to customers on the Internet.



SaaS - Software as a Service

- For many business applications such as business applications, it is one of the standard delivery models, including office software, messaging software, payroll processing software, and many more. Software as a Service (SaaS) is used by most leading organizations.
- Often known as host software, on-demand software, and web-based software are the SaaS applications.
- It allows users to connect to and use cloud-based applications over the Internet.
- E-mail, calendar, and office tools (such as Microsoft Office 365) are examples of these applications.

Tip: When to Use SaaS

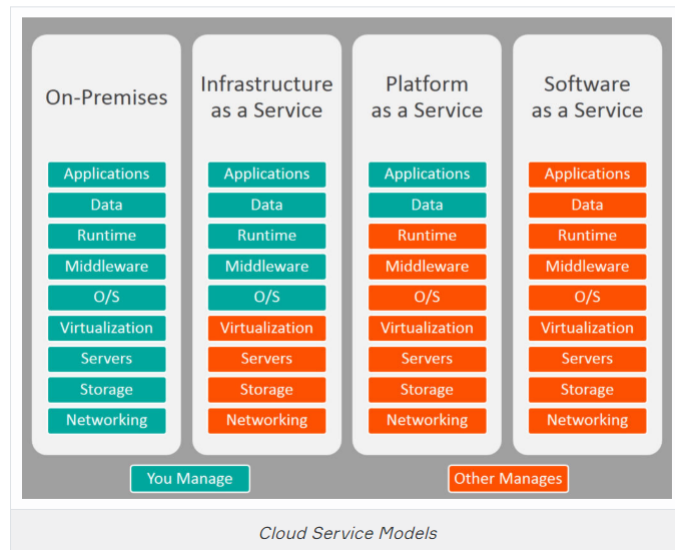
- SaaS platforms are ideal for when you want an application to run smoothly and reliably with minimal input from you.

Comparison of Cloud Service Models

Firstly, let's recap all the service types shortly.

- **On-premise:** Installed software in the same building as your company
- **IaaS:** Cloud-based services, computing such as storage, networking, and monitoring pay-as-you-go.
- **PaaS:** Most often designed to reduce the need for system administration on top of an IaaS model.
- **SaaS:** Provides ready-to-use, out-of-the-box solutions that meet a specific business requirement (such as website or email).

To better understand the whole concept, let's look at the image below.

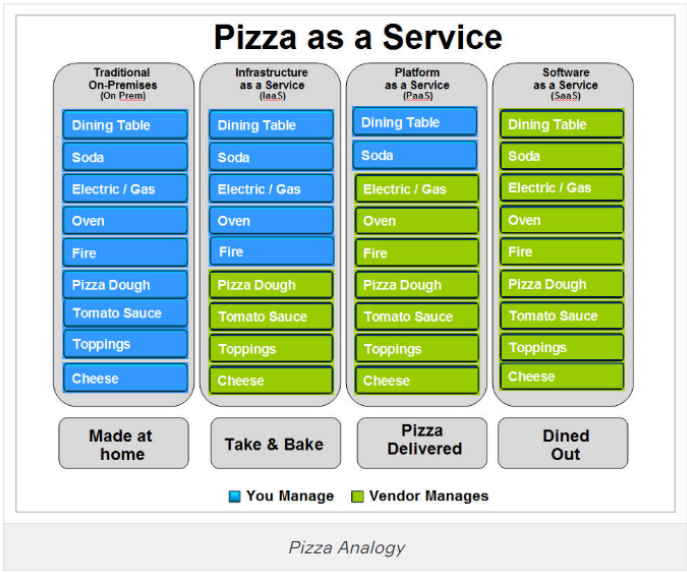


As you see, from On-premise to SaaS, the services offered to you are gradually increasing, and ultimately almost everything you need is provided by the cloud provider.

- IaaS can be thought of as renting a computer through the cloud provider. It means that you have all the control here, including the operating system level, etc.
- In PaaS, the cloud provider here puts another level of abstraction for you to manage your needs easily. It expands the service frame and offers a wide range of solutions for applications. It saves you money and makes it easier for a distributed workforce to work together.
- In SaaS, software applications do not need to be installed and run on your device. Once you sign in to your account online, everything is available on the internet.

Pizza Analogy for Service Model Comparison

Sometimes concepts can cause confusion. Therefore, it is sometimes useful to explain the application areas of the terms and their comparison by giving examples from daily life. If we talk about the below pizza example that is frequently used to explain the cloud deployment models, it will be easier to revive the concepts in our minds. It's all about the control of the whole process.



The Pizza-as-a-Service metaphor was firstly introduced by Albert Barron in 2014 as an interesting explanation of 'as a service' models by comparing them with the product lifecycle of pizza. According to this approach:

- **On-Premise Model;** you take all the ingredients of the pizza and make it yourself at home.
- **IaaS Model;** you buy some ingredients and packaged dough and make it yourself at home.
- **Paas Model;** you order pizza delivered to your home.
- **Saas Model;** you take your whole family and go to the pizzeria.

In each case you're still having pizza however in some cases, you do all of the work and others you have other people do the work for you.

What is Virtualization?

Virtualization was first found by IBM in January 1967 as IBM Mainframe systems. The host computer is divided by specific software, serving multiple users simultaneously.

Virtualization refers to the operation of multiple operating systems called guests by sharing the same physical equipment resources.

- It allows you to use a physical machine's full capacity by distributing its capabilities among many users or environments.
- This will help the user to share a single physical resource instance or application with multiple users by providing multiple machines at the same time.
- The machine on which the virtual machine is to be created is called a host machine and the virtual machine is referred to as a guest machine.

Virtualization is software that renders computing environments independent of physical infrastructure, while cloud computing is a service that provides on-demand virtual computing resources (information and/or data).

- Cloud computing virtualization is a mechanism in which cloud users share the data in the cloud that can be device applications, etc.
- Virtualization systems create a logical layer between the user and the hardware, preventing the user from directly accessing physical system resources.
- This layer is a logical layer called Hypervisor or VMM (Virtual Machine Monitor), called the core of virtualization, that receives user requests and transmits them appropriately to the hardware.
- A hypervisor is synchronization between the server and the virtual environment and distributes resources through different virtual environments.

Main Virtualization Types

Since virtualization has so many varieties, it would not be right to limit the types of virtualization to a few areas. However, we can briefly define virtualization as 'doing more than one' and limit it to the most widely used types of business. Now we will focus on the main types of virtualization as below:

- Hardware Virtualization
- Software Virtualization
- Server Virtualization
- Storage Virtualization
- Operating System - OS Virtualization

Hardware Virtualization

Hardware virtualization is a type of virtualization that enables computers to be virtualized and moved to the data center and then to be used by end-users by accessing these resources over the network or the internet. It is the virtualization of computers as full hardware platforms, other logical abstractions of their part, or only the features needed to run different operating systems.



The hardware on the existing physical system is produced more than one virtual and provides complete isolation between guest operating systems. While this is the case, you can add, install and run guest (virtual) operating systems running on real hardware. The hypervisor layer will produce virtual hardware and communicate with each other.

Software Virtualization

Virtualization is done by special software installed on the operating system. The installed software creates one special file and keeps it for use by operating systems that can be run by the software.

The software runs the selected operating system exactly as if it were installing an operating system on a computer and shows it to you in the graphical interface.

Without the need to install software on a client, it is the fulfillment of the requirements of software on the server.



Virtualized software is an application that is loaded in its own network. Example of software virtualization is VMware, virtual box, etc.

Server Virtualization



Server Virtualization

Virtualizing the server is partitioning a physical server into multiple virtual servers and used to optimize the efficiency of the server. Physical server partitioning software is used in many virtual environments, called virtual servers or private servers.

Each virtual server runs its own program and operating system. We can have a number of virtual servers on the same computer instead of having a separate computer for each web server.

Storage Virtualization



Storage Virtualization

Physical storage is partitioned by logical storage and abstracted between each other. It refers to the retention of data in a virtualized file.

It can also be named as a category of an available storage unit that manages simply from a central console. Device operating systems and applications can use the disks for writing directly on their own.

Such virtualization provides numerous advantages such as fast data backup, accomplishment, and recovery.

Operating System - OS Virtualization

It shares the operating system in common data sources, providing the advantage of maintenance, repair, and enhanced system security in other users' operating systems. It provides isolation of those who use virtualization software in the same way.



OS Virtualization

Nothing is pre-installed or permanently loaded on the local device with the help of OS virtualization and no hard disk is needed. Using a kind of virtual disk, all run from the network. The client connects to this virtual disk via the network and boots with the virtual disk enabled operating system.