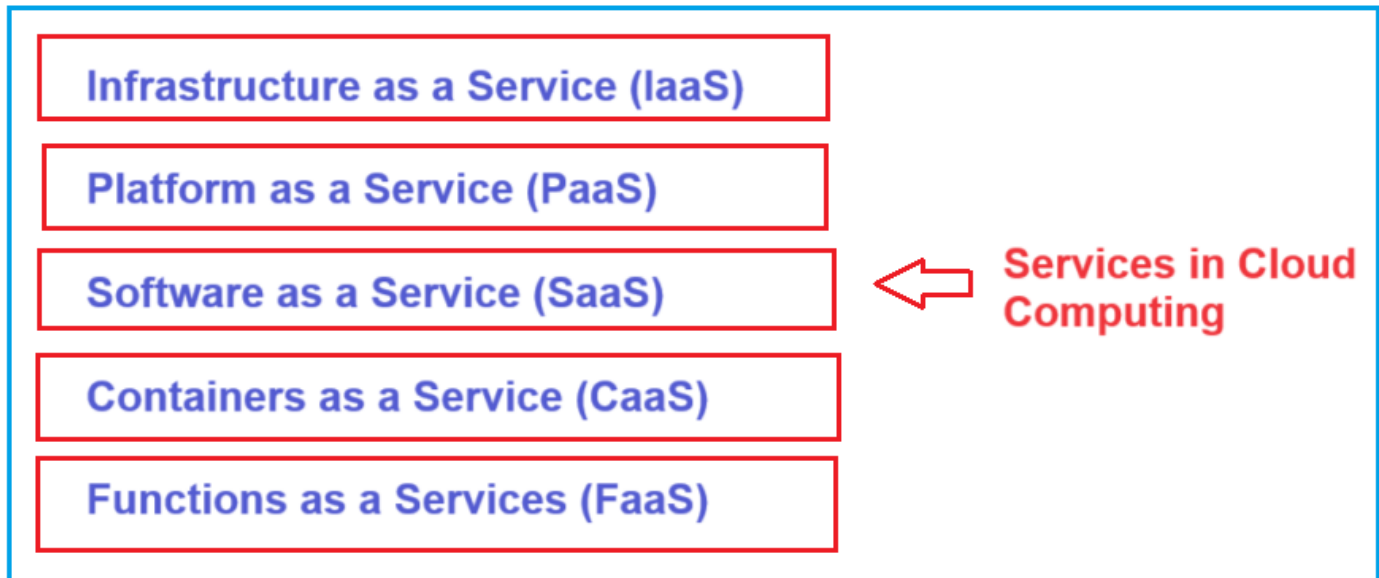


Different Types of Services in Cloud Computing

In cloud computing, services are typically **categorized into five main types**: Infrastructure as a Service (**IaaS**), Platform as a Service (**PaaS**), Software as a Service (**SaaS**), Containers as a Service (**CaaS**), and Functions as a Services (**FaaS**).



Infrastructure as a Service (IaaS):

This service model provides **virtualized computing resources** over the Internet. IaaS allows users **to rent IT infrastructure** such as servers, virtual machines, storage, networks, and operating systems from a cloud provider on a **pay-as-you-go basis**. This model offers maximum flexibility and control over IT resources and is widely used for migrating existing applications to the cloud.

Features:

- Virtual machines, storage, and networks
- High flexibility and scalability
- Pay-as-you-go pricing model

Examples:

- Amazon Web Services (AWS) EC2
- Microsoft Azure Virtual Machines
- Google Cloud Compute Engine

Platform as a Service (PaaS):

PaaS provides a platform allowing customers **to develop, run, and manage applications** without the complexity of building and maintaining the infrastructure **typically associated with developing and launching an app**. PaaS can streamline workflows when multiple developers are working on the same project. It simplifies the process of developing and deploying applications.

Features:

- **Development frameworks** and tools
- Middleware and database management
- Built-in scalability and load balancing

Examples:

- Google **App Engine**
- Microsoft Azure **App Services**
- AWS **Elastic Beanstalk**

Software as a Service (SaaS):

SaaS delivers **software applications over the Internet** on a subscription basis. The service **provider hosts and maintains** these applications, making them accessible from anywhere. It is the most widely recognized form of cloud service. **SaaS** providers manage the infrastructure, platforms, and software, and users connect to the service via a web browser.

Features:

- **Accessible via** web browsers
- Managed by the service provider
- Automatic updates and patches

Examples:

- Google Workspace (formerly G Suite)
- Microsoft Office **365**
- Salesforce (*cloud-based Customer Relationship Management (CRM) platform*)

Function as a Service (FaaS):

FaaS, also known as **serverless computing**, allows developers **to execute code in response to events** without managing the underlying infrastructure. It is a **subset of PaaS**. The cloud provider automatically handles the physical hardware, virtual machine operating systems, and web server software management.

Features:

- **Event-driven** execution
- Automatically scales with demand
- Pay only for the execution time

Examples:

- **AWS Lambda**
- Google Cloud Functions
- Azure Functions

Note:

- **Serverless computing** is a cloud model where **we write code, and the cloud provider runs it for us** — we **do not manage servers** at all.
- “Serverless” does **not** mean there are no servers. It means **developers don’t worry about servers**.

Container as a Service (CaaS):

CaaS is a cloud service model that allows users to manage and deploy containers (*standardized executable components combining application source code with the operating system (OS) libraries and dependencies required to run that code in any environment*) using container-based virtualization. A **CaaS (Container as a Service) provider** usually give us a tool like **Kubernetes** that **automatically manages containers**, so we don’t have to do it manually.

Features:

- **Automated deployment**, scaling, and management of containers.
- **Easily scale** containerized applications to **handle varying loads**.
- **Built-in security** features for container isolation and access control.
- Tools for monitoring container performance and **logging activities**.
- Containers can be **easily moved** across different environments.

Examples:

Google Kubernetes Engine (GKE)

Azure Kubernetes Service (AKS).

Amazon Elastic Kubernetes Service (EKS)

Infrastructure as a Service in Cloud Computing

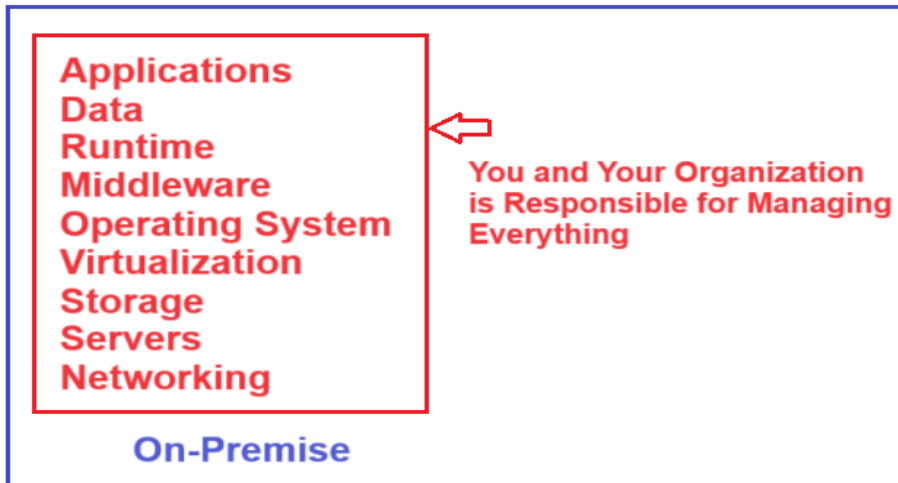
How do we manage an On-Premise Data Center or Server?

Managing **an on-premises** data center or server involves various tasks. Without cloud services, we need to manage everything on-premise such as.

- **Purchasing** Physical Servers, Storage, and related hardware
- **Install** and set up the network
- **Setting up** the server room or data center

- Ensure the **main power supply**, backup power supply, cooling system, etc, are in place.
- Install and **configure virtualization** software, operating system, runtime components, etc.
- Install, configure, and **manage your custom or packaged apps** and data.

So, the organization is responsible for **managing everything** without the cloud.

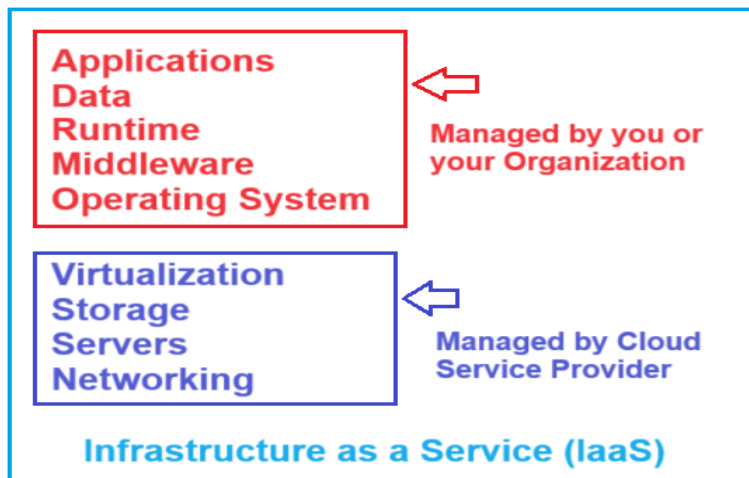


- **Applications:** Applications **refer to software programs** or services that users access over the internet. These can range from simple web applications to complex enterprise software.
- **Data:** Data **refers to information that can be processed**, stored, or transmitted by computer systems. This includes databases, files, documents, or any digital information.
- **Runtime:** Runtime **refers to the execution environment** where applications run. It includes the environment, resources, and services required for the application to operate correctly.
- **Middleware:** Middleware **refers to the software that connects different applications** or services. It acts as a bridge between various components of an application stack, enabling communication and integration. Middleware can include services like **message queues, application servers, database management systems (DBMS)**, etc.
- **Operating System:** The operating system (OS) is the **software that manages hardware resources and provides common services** for computer programs. It acts as an **intermediary between applications and hardware**, handling tasks such as memory management, process scheduling, file management, and user interface interactions.
- **Virtualization:** Virtualization **refers to the creation of virtual versions of hardware**, operating systems, storage devices, or network resources. It enables multiple virtual instances (such as virtual machines or containers) to run simultaneously on a single physical machine, optimizing resource utilization, scalability, and flexibility.
- **Storage:** Storage **refers to the physical or virtual devices and systems used to store and retain data** persistently. It includes hard disk drives (HDDs), solid-state drives (SSDs), and other storage devices. Storage systems provide data accessibility, durability, and reliability for applications and users.
- **Servers:** Servers are **physical or virtual machines that host applications**, services, or data. Servers often host and deliver applications, manage data storage, or provide access to shared resources and services over a network.
- **Networking:** Networking **involves the systems, protocols, and infrastructure** used to establish communication and connectivity between computers, devices, or systems within a network. It enables data exchange, resource sharing, and collaboration between users and applications across local and wide area networks (LANs/WANs).

It's important to note that managing an on-premises data center requires a significant investment of time, resources, and expertise. Many organizations opt for cloud computing solutions (such as *IaaS, PaaS, or SaaS*) to offload some of these responsibilities and benefit from cloud provider services.

What is Infrastructure as a Service (IaaS) in Cloud Computing?

- Infrastructure as a Service (**IaaS**) in cloud computing **refers to a model** where cloud providers like Microsoft Azure, Amazon Web Services, or others offer **virtualized computing resources** over the Internet. Users can rent and manage virtual machines (VMs), storage, networking, servers, and other computing resources on a **pay-as-you-go** basis.
- There is **no need for our organization to purchase** and manage the infrastructure. **It is the cloud service provider** that is responsible for
 - Providing Physical Servers, Storage, and related hardware
 - Install and set up the network
 - Ensure a proper power supply, backup power supply, cooling system, etc., is in place.
 - The cloud service provider is also responsible for setting up, securing, and managing the cloud data center.



Infrastructure as a Service (IaaS) works like this:

- The cloud service provider hosts the infrastructure (servers, storage, networking, and virtualization) in its data center. **We use this infrastructure on demand** over the Internet or a private network, and **we pay only for the resources and time we use**.
- The provider manages the hardware and basic infrastructure, but **we are responsible for the operating system, middleware, runtime, data, and applications**. This gives **us more control**, allowing **us to install any operating system**, such as Windows or Linux, and use the infrastructure for different purposes.
- For example, **we can host and run web applications**, or **use it for storage** by installing databases like SQL Server or Oracle to store business data. Because it provides hardware resources on demand, **IaaS is also called Hardware as a Service (HaaS)**.

Common Use Cases of Infrastructure as a Service (IaaS):

1. **Web Hosting:** Hosting websites on virtual servers that are scalable with changing demand.
2. **Storage, Backup, and Recovery:** Managing data with scalable options and without the physical limitations of onsite hardware.
3. **Web Apps:** Hosting, developing, and maintaining web applications with the ability to scale infrastructure as traffic grows.
4. **High-Performance Computing:** Using complex and high-performance computations such as scientific simulations, financial modeling, and real-time data processing.

Benefits of Infrastructure as a Service (IaaS)

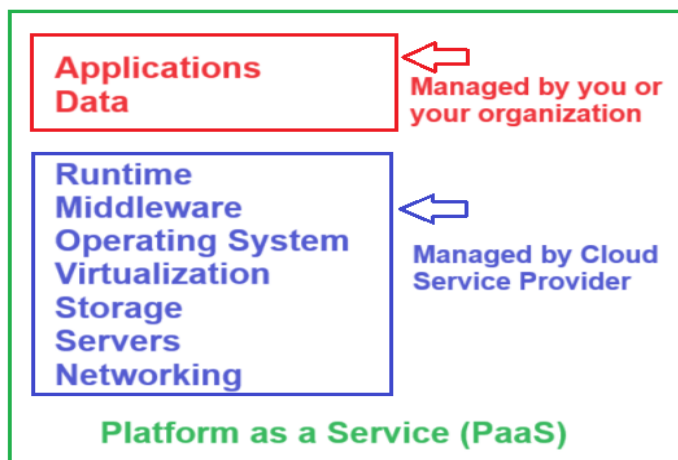
Benefits of Infrastructure as a Service (IaaS)

1. **Reduced Financial Risk:** With IaaS, we rent infrastructure from a cloud provider and pay only for what we use, avoiding huge upfront costs and reducing financial risk if a project fails.
2. **Faster Deployment Speed:** IaaS allows us to create virtual machines and set up servers, storage, and networks within minutes, making deployment much faster than traditional setups.
3. **Unlimited Scalability:** IaaS lets us easily increase or decrease resources like CPU, memory, and storage based on demand, ensuring efficient usage and cost savings.
4. **Improved Security:** IaaS providers secure the infrastructure with tools like encryption, firewalls, and monitoring, helping protect our data and systems from threats.
5. **Pay-as-You-Go Pricing Model:** IaaS charges us only for the resources we use, eliminating upfront costs and making it flexible and cost-effective for any organization.

Popular IaaS Providers:

- **Amazon Web Services (AWS):** Offers a wide range of IaaS services under its **EC2** (Elastic Compute Cloud), **S3** (Simple Storage Service), and **VPC** (Virtual Private Cloud) offerings.
- **Microsoft Azure:** This provider provides IaaS capabilities through **Azure Virtual Machines**, Azure Storage, and Azure Virtual Network, among other things.
- **Google Cloud Platform (GCP):** Offers IaaS services like **Compute Engine for VMs**, Cloud Storage for scalable storage solutions, and Virtual Private Cloud (VPC) for networking.

Platform as a Service in Cloud Computing



- Platform as a Service (PaaS) is a cloud computing model that provides a complete platform for developing, running, and managing applications.
- It allows users to build applications without worrying about hardware and infrastructure management.
- The main goal of PaaS is to simplify the application development process
- In Platform as a Service (PaaS), the cloud service provider manages the underlying infrastructure, including networking, servers, storage, and virtualization, and handles these components automatically.
- The users (developers) are responsible for the operating system, runtime environment (such as Java or .NET), application data, and their applications, which reduces their overall workload.

- PaaS is mainly used by software developers and development teams, as it provides all the tools required for application development in one place and supports both development and deployment.
- It is suitable for building web applications, mobile applications, and enterprise-level software systems.

Example:

- Suppose we want to build a data-driven web application.
- Normally, we need several components to do this.
- These include:
 - A framework like ASP.NET Core or Java
 - A database like SQL Server or Oracle
 - A web server to run the application
- In a traditional setup, we must:
 - Purchase all required software
 - Install and configure them manually
 - Set up a development environment
 - Maintain and update the system regularly
- This process requires time, effort, and high cost.

Common Uses of PaaS (Simple Form)

- **Software Development:**
PaaS provides a complete environment where developers can easily build and deploy applications, from simple apps to large enterprise systems.
- **Business Analysis:**
PaaS helps businesses analyze their data and create useful reports and dashboards.
- **API Development and Management:**
PaaS makes it easier to create, manage, and scale APIs efficiently.

Advantages of Platform as a Service (PaaS) in Cloud Computing

1. Reduces Development Time

PaaS saves a lot of time in application development because there is no need to buy hardware or install software manually. Developers can start working in minutes and use ready-made templates and tools like security and search features.

2. Supports Global Teams

PaaS allows developers to work from anywhere in the world using an internet connection. Team members can easily collaborate and work together on the same project.

3. Supports Multiple Platforms

PaaS allows developers to create applications for computers, mobile devices, and web browsers. It makes cross-platform development easier and faster.

4. Affordable (Low Cost)

PaaS uses a pay-as-you-go model, so users only pay for what they use. It removes the need to buy expensive hardware and software, making it affordable for everyone.

5. Multi-Tenant Architecture

PaaS allows multiple users to use the same platform at the same time. Each user's data remains secure and separate, which helps reduce cost and use resources efficiently.

PaaS Cloud Providers:

The following are some of the popular PaaS Cloud Providers:

- **Microsoft Azure:** Offers a platform for building, deploying, and scaling web apps and APIs. Offers PaaS capabilities as part of its cloud offerings, including app services, Azure SQL Database, and Azure DevOps.
- **Google App Engine:** Provides a platform for building and deploying scalable web applications and mobile backends in any language.
- **AWS Elastic Beanstalk:** Provides an easy-to-use service for deploying and scaling web applications and services.
- **IBM Cloud Foundry:** Offers an open-source cloud platform that allows developers to build, deploy, and run applications easily.

Software as a Service (SaaS) in Cloud Computing



What is Software as a Service (SaaS) in Cloud Computing?

Software as a Service (SaaS) is a cloud computing model in which software applications are provided over the Internet, allowing users to access them through a web browser without needing to install or maintain the software on their own devices, because everything is managed by the cloud service provider.

In this model, the cloud provider takes care of all technical tasks such as purchasing and setting up hardware, installing operating systems, managing virtualization, setting up networks, and maintaining middleware, runtime, and applications, so users do not have to worry about any of these things.

The software runs on the cloud provider's servers in their data centers, and all the data is also stored there, which means users simply use the application through the Internet without handling storage or system management.

This makes SaaS very easy to use because everything is already set up and maintained, and users only need an internet connection to access the software and perform their tasks.

Additionally, SaaS follows a pay-as-you-go model, where users pay a monthly fee based on their usage, making it cost-effective and convenient for both individuals and businesses.

Who Uses Software as a Service (SaaS)?

- SaaS is used by everyone, including individuals and organizations of all sizes – small, medium, and large enterprises.
- Most people use at least 2 to 3 SaaS applications in their daily life.
- **Examples of SaaS applications:**
 - GMAIL
 - Netflix
 - Amazon Prime
 - Dropbox
 - Google Drive
 - Office 365
- For example, GMAIL is hosted by Google on their servers in data centers.
- We do not need to install or host anything on our computers or laptops.
- To use GMAIL, we simply open a web browser, go to GMAIL.com, and access the software over the Internet.

Benefits of Software as a Service (SaaS) in Cloud Computing

- **Very Easy to Get Started:** SaaS applications are very easy to start using because you can access them through a web browser without needing to install hardware or software.
- **Accessibility:** You can use SaaS applications from anywhere and on any device as long as you have an internet connection.
- **Automatic Updates:** The cloud provider automatically installs updates and patches, often without any downtime, so you don't need to manage them yourself.
- **Flexible Usage-Based Pricing:** You only pay for what you use, and you can easily increase or decrease the number of users based on your needs.
- **Reduced Financial Risk:** SaaS reduces financial risk because you can start with a few users or a free trial and scale only if the application adds value.
- **Affordability:** SaaS applications are affordable because the pay-as-you-go model allows small and medium businesses or individuals to use expensive software without buying it outright.

Differences Between IaaS, PaaS, and SaaS in Cloud Computing

Feature	IaaS (Infrastructure as a Service)	PaaS (Platform as a Service)	SaaS (Software as a Service)
What it Provides	Virtualization, Storage, Servers, Networking	Runtime, Middleware, OS, Virtualization, Storage, Servers, Networking	Applications, Data, Runtime, Middleware, OS, Virtualization, Storage, Servers, Networking
When to Use	Full control over infrastructure, developing/testing environments, high-scale web apps, hosting sites with fluctuating demand	Develop or deploy apps quickly without managing infrastructure, streamline workflows for multiple developers	Web or mobile access apps, standardized business processes, collaboration tools, CRM/ERP/business management tools
Benefits	Flexibility and scalability, cost savings, full control, easy to manage and automate	Simplifies development, testing, and deployment, all tools in one platform, cost-effective for developers	No installation or maintenance, accessible from anywhere, scalable usage, cost-effective subscription model
Limitations	Requires technical expertise, security and compliance are user's responsibility	Less control over infrastructure, potential vendor lock-in, limited to provider's features	Limited customization, data security concerns, depends on provider for uptime and performance
Examples / Service Providers	AWS – EC2, Microsoft Azure – Virtual Machines, GCP – Compute Engine	AWS – Elastic Beanstalk, Microsoft Azure – App Service, GCP – App Engine	Google Workspace, Microsoft Office 365, Salesforce, Dropbox