# Cloud Computing in ICT

**chapter 05**
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# Objectives of the Session

1. Understand what cloud computing is and its components.

2. Explore the different cloud computing models: IaaS, PaaS, and SaaS.

3. Learn the importance of cloud services in Artificial Intelligence (AI).

4. Understand how cloud platforms are used for data storage and remote processing in AI.

# What is Cloud Computing ?

**Definition:**

**Cloud computing** is the delivery of computing services—such as servers, storage, databases, networking, software, analytics, and intelligence—over the internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale. Instead of owning and maintaining physical data centers and servers, organizations can rent computing resources on-demand from cloud service providers.
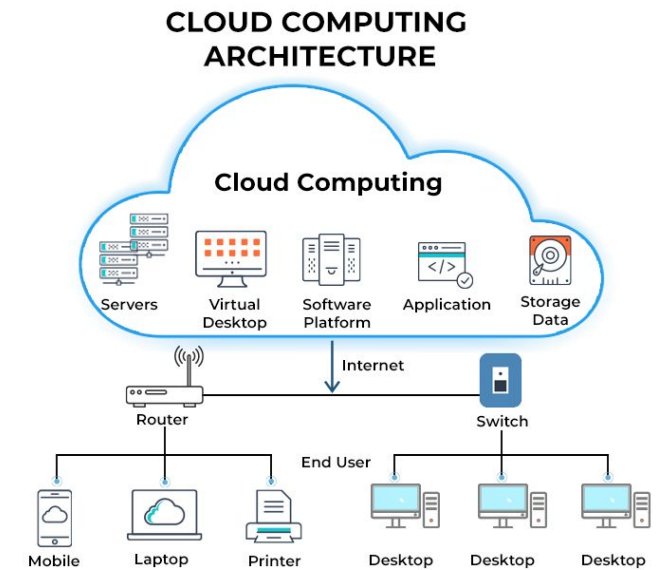
# Cloud Computing Architecture?
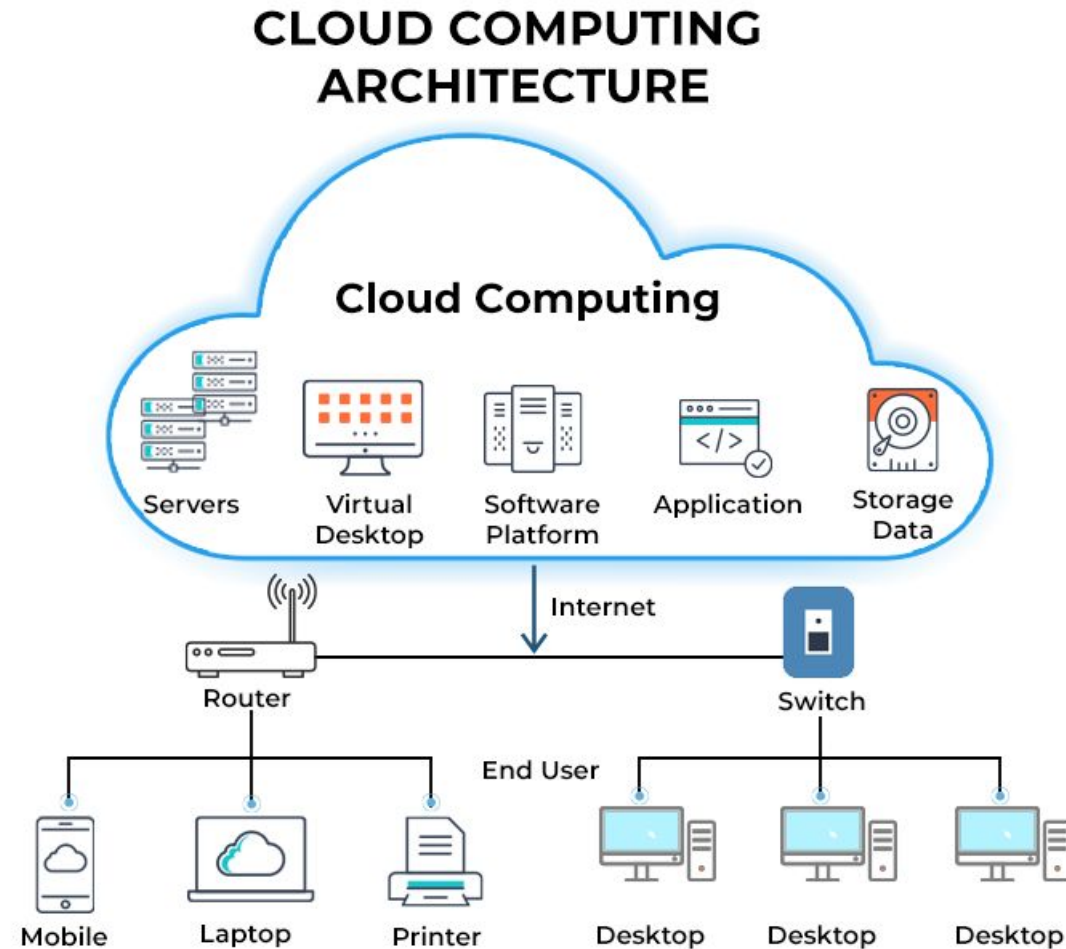
# Cloud Computing Architecture?

Cloud computing is divided into two layers:

**Front-End Layer**:

- This is the user interface where people interact with the cloud.
- It allows users to access and manage their data stored in the cloud via software or web applications.

# Cloud Computing Architecture?

The **back-end layer** in cloud computing consists of the hardware and software that manage cloud services, including computers, servers, central servers, and databases. This layer is responsible for securely storing data.

**Middleware**: Software used by central servers to connect databases with applications, ensuring smooth communication between devices in the cloud.



CLOUD COMPUTING ARCHITECTURE
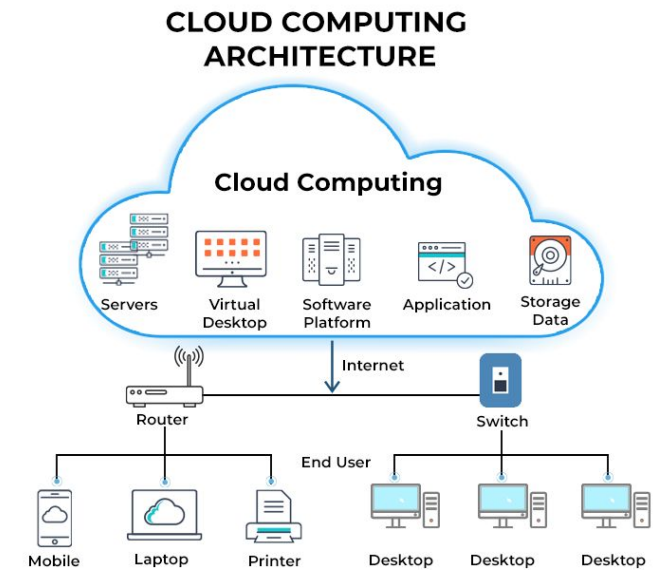
# Benefits of Cloud Computing in ICT

1. **Cost Savings:** Reduces capital expenditure on physical hardware.

2. **Accessibility:** Resources can be accessed from anywhere with an internet connection.

3. **Scalability:** Easily scale up or down based on demand.

4. **Automatic Updates:** Software and hardware are automatically maintained and updated by the cloud provider.

5. **Disaster Recovery:** Data and applications are safely stored and can be restored in case of a disaster.

# Cloud Computing Architecture?
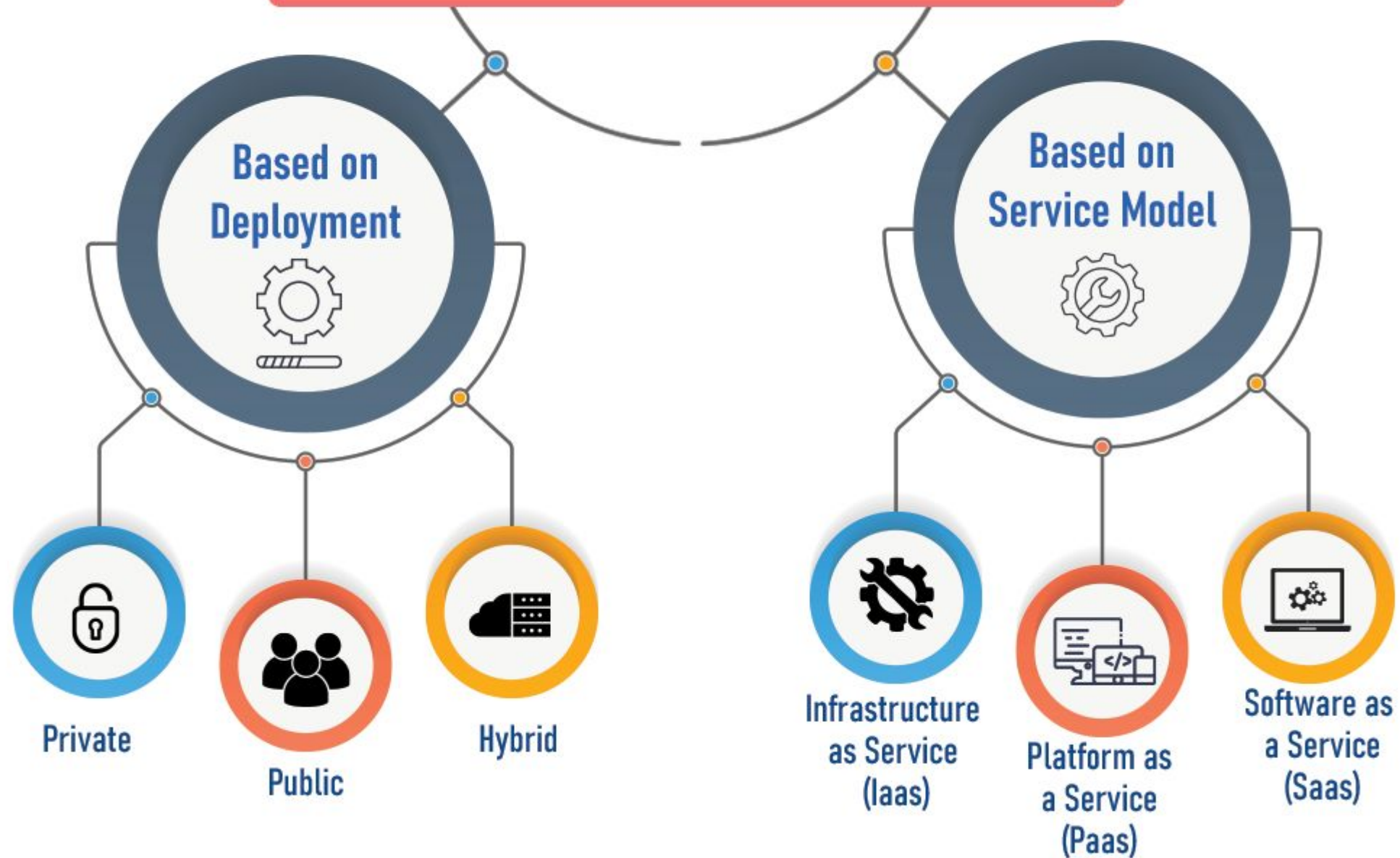
**Types of Cloud Services**:

1. **IaaS**: Provides virtual infrastructure (e.g., servers, storage).
2. **PaaS**: Offers platforms for developers to build and deploy applications.
3. **SaaS**: Delivers software applications online (e.g., Google Workspace, Office 365).

**Cloud Models**:

4. **Public Cloud**: Shared services available to multiple users.
5. **Private Cloud**: Exclusive to one organization.
6. **Hybrid Cloud**: A mix of public and private clouds.

# TYPES OF CLOUD COMPUTING

TOOLBOX

**Based on Deployment**

- Private
- Public
- Hybrid

**Based on Service Model**

- Infrastructure as Service (Iaas)
- Platform as a Service (Paas)
- Software as a Service (Saas)

# Cloud Deployment Models

**Public Cloud:**

- Services are offered to the public by a third-party provider.
- Example: Amazon Web Services (AWS), Microsoft Azure, Google Cloud.

**Private Cloud:**

- Services are used exclusively by one organization.
- Example: Government or large enterprises with specific security needs.

**Hybrid Cloud:**

- A mix of public and private cloud services.
- Example: A company may store sensitive data in a private cloud but use public cloud services for other applications.

# Types of Cloud Services

Cloud computing services are divided into three main models:

- **IaaS (Infrastructure as a Service)**:
Provides virtualized computing resources like servers, storage, and networking over the Internet.

- **PaaS (Platform as a Service)**:
Provides hardware and software tools (e.g., OS, middleware) so developers can build applications without worrying about the underlying infrastructure.

- **SaaS (Software as a Service)**:
Delivers fully functional applications over the Internet, usually via a browser.

# Infrastructure as a Service (IaaS)

**Definition**:

IaaS is also known as Hardware as a Service (HaaS). IaaS provides virtualized computing resources over the Internet. The user is responsible for managing operating systems, storage, and applications, while the provider handles the physical infrastructure.
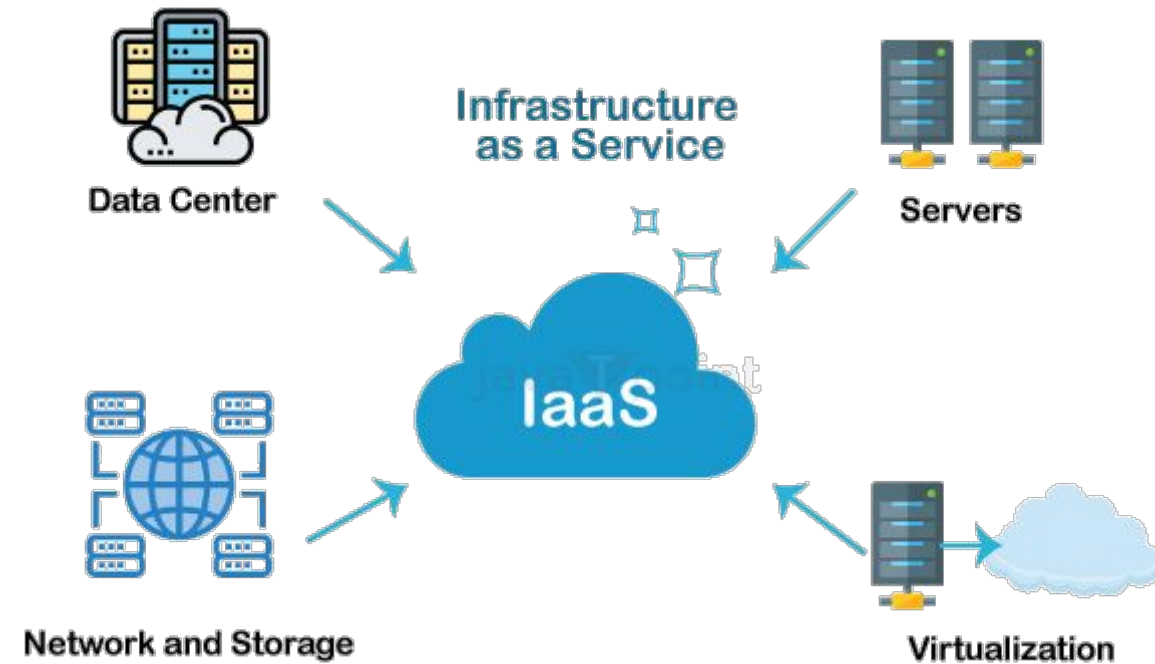
**Examples**:

1. Amazon EC2 (Elastic Compute Cloud)
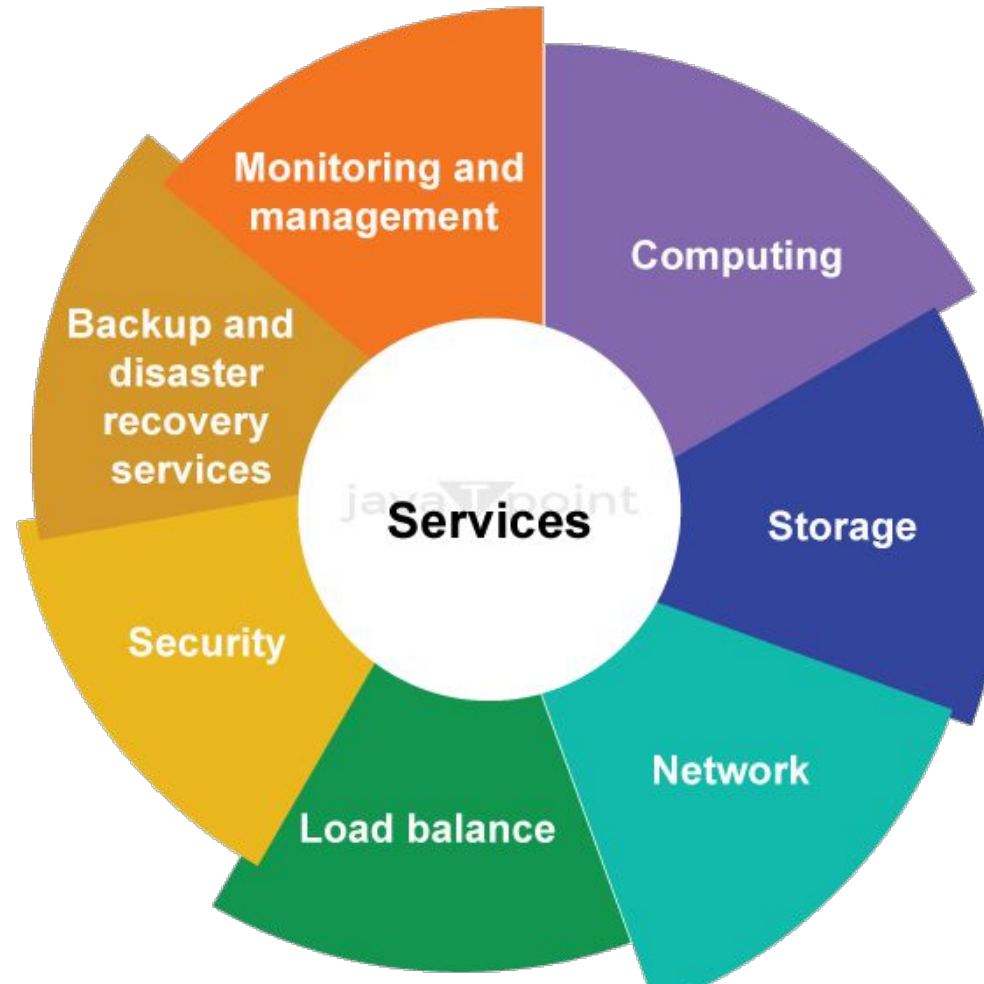2. Google Compute Engine
3. Microsoft Azure Virtual Machines

# Infrastructure as a Service (IaaS)

**Use Case**:

Developers or IT teams can rent virtual servers and storage for building and deploying applications without purchasing physical hardware.

# IaaS provider provides the following services

# Platform as a Service (PaaS)

- **Definition**:
  PaaS provides a platform that allows developers to build, test, and deploy applications without having to manage the underlying infrastructure.

- **Examples**:

1. Google App Engine

2. Heroku

3. Microsoft Azure App Services

- **Use Case**:
  Developers can focus on writing code and building applications without worrying about server management, databases, or networking.

# Software as a Service (SaaS)

- **Definition**:
  SaaS delivers fully functional software applications over the Internet, accessible through a web browser. Users don't need to install or maintain any software locally.

- **Examples**:

- Google Workspace (Google Docs, Sheets, etc.)

- Salesforce (CRM software)

- Microsoft Office 365

- **Use Case**:
  End-users can access software through the cloud without worrying about installation or maintenance (e.g., email, productivity tools).

# Importance of Cloud Services in AI

- **Scalability**:
  Cloud services allow AI developers to scale processing power, storage, and data capacity on demand, which is essential for training large AI models.

- **Cost Efficiency**:
  AI applications require massive computing resources, and cloud services provide a cost-effective solution by allowing users to pay for resources as needed rather than investing in costly hardware.

- **Accessibility**:
  AI developers can access cloud-based AI platforms (e.g., Google AI, AWS SageMaker) from anywhere in the world.

# Cloud Services for Data Storage in AI

- **Data Storage**:
  AI applications often process huge amounts of data. Cloud platforms like Amazon S3 or Google Cloud Storage allow for cost-effective and scalable data storage.

- **Data Management**:
  Cloud services provide integrated tools for data management, making it easier to organize, clean, and process data for AI algorithms.

- **Examples**:

- **Amazon S3**: Object storage for AI datasets.

- **Google Cloud Storage**: Secure storage for AI projects.

# Remote Processing in AI

- **High-Performance Computing**:
  AI models require immense processing power, especially during the training phase. Cloud platforms provide access to high-performance computing (HPC) resources, such as GPUs and TPUs, which significantly speed up model training.

- **Examples**:

- **Google Cloud AI Platform**: Offers powerful machine learning tools and hardware accelerators (e.g., TPUs).

- **AWS SageMaker**: Allows developers to build, train, and deploy AI models using cloud-based processing resources.

# AI Tools on Cloud Platforms)

- Cloud platforms provide pre-built AI tools and services, making it easier to develop and deploy AI applications. Some popular tools include:

- **AWS SageMaker**: A fully managed service to build, train, and deploy machine learning models.

- **Google AI Platform**: Tools for data scientists and developers to quickly create and deploy machine learning models.

- **Microsoft Azure Machine Learning**: Offers a complete suite of tools for AI development, from model training to deployment.

# Example: Using Cloud in AI Application)

- **Use Case**: Training an AI Model for Image Classification
- **Step 1**: Store large image datasets in Amazon S3 (IaaS).
- **Step 2**: Use AWS SageMaker (PaaS) to train the machine learning model.
- **Step 3**: Deploy the trained model as a web application (SaaS) accessible to users via a browser.

# Summary

- Cloud computing provides flexible, scalable, and cost-effective resources for ICT and AI.
- There are three main service models: IaaS, PaaS, and SaaS.
- Cloud services are critical for data storage, remote processing, and scalability in AI application