UNIT – I

Cloud Computing

1. Computing Paradigms

Meaning

Computing paradigms describe the different ways in which computing systems are designed to process data, manage resources, and execute tasks. Over time, computing has evolved from simple centralized systems to highly scalable cloud-based systems.

1.1 Centralized Computing

In centralized computing, all processing is performed on a single central system such as a mainframe or server. All users connect to this central machine using terminals or thin clients. The central system is responsible for processing, storage, and control.

Example

Early banking systems used mainframes where all transactions were processed in a single system.

Advantages

- Easy to manage and control
- High data consistency
- Strong security control at one point

Disadvantages

- Single point of failure (if server fails, everything stops)
- Not scalable for large users
- High load on central

1.2 Client–Server Computing

Client–server computing divides tasks between clients and servers. The client sends requests, and the server processes them and sends responses back. This model is widely used in modern applications.

Example

When you use a browser to access a website:

- Browser = Client
- Website server = Server

Advantages

- Better resource utilization
- Scalable architecture
- Easier maintenance than centralized systems

Disadvantages

- Server overload can occur
- Dependency on network connectivity

1.3 Distributed Computing

Distributed computing consists of multiple independent computers connected via a network, working together as a single system. Each system shares workload and communicates to complete tasks.

Example

Google search engine uses distributed systems to handle billions of queries.

Advantages

- High performance and speed
- Fault tolerance (if one node fails, others continue)
- Resource sharing

Disadvantages

- Complex design and coordination
- Network dependency

1.4 Parallel Computing

Parallel computing uses multiple processors to execute different parts of a task simultaneously. A large problem is divided into smaller sub-tasks and processed at the same time.

Example

Weather forecasting systems and AI model training use parallel computing.

Advantages

- Very fast processing
- Efficient for large datasets

Disadvantages

- Expensive hardware required
- Complex programming model

1.5 Grid Computing

Grid computing connects computing resources from different geographical locations and organizations to work on a common problem. These systems are loosely connected and often heterogeneous.

Example

SETI@home project used grid computing to analyze radio signals for extraterrestrial life.

Advantages

- Uses idle computing resources
- Suitable for large scientific problems

Disadvantages

- Security concerns
- Difficult resource coordination

1.6 Cloud Computing

Cloud computing is a modern computing paradigm where computing resources such as servers, storage, and software are delivered over the internet on demand. Users do not need to own physical infrastructure.

Example

Google Drive provides cloud storage services without requiring physical storage devices.

Advantages

- Pay-as-you-use model
- Highly scalable
- Easy access from anywhere

Disadvantages

- Internet dependency
- Privacy concerns

1.7 Edge Computing

Edge computing processes data closer to the source (edge devices) instead of sending it to a central cloud server. This reduces latency and improves real-time performance.

Example

Self-driving cars process sensor data locally to make instant decisions.

Advantages

- Low latency
- Faster decision-making
- Reduces cloud load

Disadvantages

- Limited processing power at edge devices
- Security challenges

2. Cloud Computing Fundamentals

Meaning

Cloud computing is the delivery of computing services such as storage, servers, databases, networking, and software over the internet. Users access these services on demand and pay only for usage.

2.1 Characteristics of Cloud Computing

1. On-Demand Self-Service

Users can automatically provision computing resources like virtual machines without human interaction.

Example

Creating an AWS EC2 instance within minutes.

2. Broad Network Access

Cloud services are accessible through standard devices such as laptops, smart phones, and tablets using the internet.

Example

Accessing Gmail from any device.

3. Resource Pooling

Cloud providers use shared infrastructure to serve multiple users dynamically. Resources are assigned based on demand.

Example

Multiple companies using the same AWS data center infrastructure.

4. Rapid Elasticity

Resources can be quickly increased or decreased depending on workload demand.

Example

E-commerce websites scaling servers during festival sales.

5. Measured Service

Cloud usage is monitored, controlled, and billed based on consumption.

Example

Paying AWS based on the number of hours a virtual machine runs.

2.2 Service Models

1. IaaS (Infrastructure as a Service)

IaaS provides virtualized computing resources over the internet. Users manage operating systems and applications, while providers manage hardware.

Examples

- Amazon EC2
- Google Compute Engine

Use Case

Running virtual servers for web applications.

2. PaaS (Platform as a Service)

PaaS provides a complete development environment, including tools, libraries, and frameworks. Developers focus only on coding.

Examples

- Google App Engine
- Microsoft Azure App Service

Use Case

Building and deploying web applications without managing servers.

3. SaaS (Software as a Service)

SaaS provides fully functional software applications over the internet. Users do not manage infrastructure or platforms.

Examples

- Gmail
- Google Docs
- Microsoft Office 365

Use Case

Directly using software through a browser.

2.3 Deployment Models

1) Public Cloud

Services are offered over the internet to multiple users. Infrastructure is shared.

Example : AWS, Google Cloud

2) Private Cloud

Cloud infrastructure is dedicated to a single organization.

Example :A bank using its own internal cloud system.

3) Hybrid Cloud

Combination of public and private cloud, allowing data and applications to be shared between them.

Example : Company storing sensitive data in private cloud and using AWS for normal applications.

4) Community Cloud

Shared by organizations with similar goals or requirements.

Example: Government departments sharing infrastructure.

3. Cloud Computing Architecture

Meaning

Cloud architecture defines the structure of cloud systems, including how components interact and deliver services.

3.1 Frontend (Client Side)

The frontend is the user interface that allows users to access cloud services. It includes web browsers, mobile apps, and client software.

Example

Using Google Drive through a browser.

3.2 Backend (Cloud Side)

The backend contains servers, databases, storage systems, and virtualization layers that process user requests.

Example

AWS data centers handling storage and processing.

3.3 Cloud Architecture Layers

1. Application Layer

Provides end-user applications delivered over the cloud.

Example : Gmail, Google Docs

2. Platform Layer

Provides tools and environments for application development.

Example: Google App Engine

3. Infrastructure Layer

Provides virtual machines, storage, and networking resources.

Example: Amazon EC2

3.4 Virtualization

Virtualization is a key technology in cloud computing that allows multiple virtual machines to run on a single physical machine. It improves resource utilization and efficiency.

Types of Virtualization

1)Full Virtualization

A complete simulation of hardware where guest operating systems run independently.

Example :VMware Workstation

2) **Para-Virtualization**

Guest OS is aware of virtualization and interacts with the host system for better performance.

Example : Xen Hypervisor

Advantages of Virtualization

- Better hardware utilization
- Cost reduction
- Isolation between users
- Easy scaling

4. Cloud Management

Meaning

Cloud management refers to controlling, monitoring, and optimizing cloud resources to ensure efficient performance and security.

4.1 Cloud Management Functions

1. Resource Provisioning

Creating and allocating cloud resources based on demand.

Example : Launching a new virtual machine in AWS.

2. Monitoring

Tracking performance of applications and infrastructure.

Example : AWS Cloud Watch monitoring CPU usage.

3. Security Management

Protecting data using encryption, authentication, and access control.

Example: AWS IAM controlling user permissions.

4. Load Balancing

Distributing traffic across multiple servers to avoid overload.

Example : YouTube distributing video requests across servers.

5. Backup and Recovery

Ensuring data is backed up and restored in case of failure.

Example : Google Drive file recovery system.

6. Cost Management

Tracking usage and optimizing cloud expenses.

Example : AWS billing dashboard showing usage cost.

4.2 Cloud Management Tools

- AWS Management Console
- Microsoft Azure Portal
- Google Cloud Console