

Cloud : It is a network of remote servers that store, manage, and process data online instead of locally.

- It allows users to access resources on demand and pay only for what they use.
- Advantages :- Scalability, cost effectively, flexibility, high availability, and global accessibility
- It is maintained by providers like AWS, Azure, or Google Cloud.

Cloud Storage :

- It is a service that allows data to be stored, accessed, and managed remotely via the internet.
- It is used for data redundancy and backup.
- Common services are AWS S3, Google Cloud Storage, Azure Blob
- Types :-
 - Object storage - used for unstructured data (e.g. images, videos - AWS S3)
 - File storage - for shared files (e.g. EFS, Azure Files)
 - Block storage - for virtual disks and databases (e.g. EBS)

Cloud Computing :

- It is the delivery of computing services (servers, storage, databases, networking, software, analytics, AI, etc.) over the internet
- The main characteristics are on-demand access, scalability, shared resources, and measured usage.
- Examples of cloud computing services are hosting applications, running databases, virtual machines, storage solutions, and AI/ML model deployment.

Cloud Delivery Models :

- It defines how services are provided to users.
The three primary models are :
 - IaaS (Infrastructure as a Service) —
Provides virtualized hardware (VMs, storage, networks).
Example : AWS EC2, Google Compute Engine
 - PaaS (Platform as a Service) —
Provides environment to deploy and develop apps.
Example : Google App Engine, AWS Elastic Beanstalk
 - SaaS (Software as a Service) —
Provides ready to use applications over the internet.
Example : Gmail, Salesforce, Microsoft 365

Cloud Computing Architecture :

It's the blueprint of how cloud components interact to deliver cloud services.

Components -

- Front End : Client side (browser, app interface)
- Back End : Cloud infrastructure - servers, storage, databases, and applications
- Cloud Service Layer : Manages services (IaaS, PaaS, SaaS).
- Network : Ensures connectivity between clients and servers
- Cloud storage : Stores persistent data.

Design goal of cloud architecture is scalability because it allows dynamic resource allocation based on demand without downtime.

Cloud Computing Actors :

Actors are the key participants that interact within the cloud environment - users, providers and intermediaries.

- Cloud Consumer : Uses cloud services (e.g. company using AWS EC2)
- Cloud Provider : Delivers cloud services (e.g. AWS, Azure, Google Cloud)
- Cloud Broker : Acts as a middleman managing service usage or integration between providers and consumers.
- Cloud Auditor : Evaluates security, performance, and

compliance of cloud services.

- Cloud Carrier : Provides the network and connectivity between consumers and providers.

Virtualization

- It is the process of creating a virtual version of hardware, operating systems, storage, or network resources using software.
- It allows multiple virtual machines (VMs) to run on a single physical machine, using software called hypervisor.
- It enables efficient resource utilization and isolation between systems.
- It enables resource sharing, scalability, and cost efficiency by separating physical resources into multiple virtual ones.

Hypervisor

- It is software that creates and manages virtual machines. It acts as a layer between hardware and the virtual environments.
- Types !
 - Type 1 (Bare metal) : Runs directly on hardware (e.g. VMware ESXi, Microsoft Hyper-V)
 - Type 2 (Hosted) : Runs on top of a host OS (e.g. VirtualBox, VMware Workstation)

used in
data centers

used for
personal
testing

Data Center: It is a facility that houses physical servers, networking equipment, and storage systems for hosting and managing data and cloud infrastructure.

- It acts as a backbone of cloud providers.
- It provides redundancy and cooling systems.
- Tier classification (Tier 1-4 based on reliability)

Cloud Native: It refers to developing and deploying applications that fully exploit the advantages of the cloud environment like scalability, resilience, and automation.

- It is designed specifically for cloud environment using containerization (e.g. Docker, Kubernetes), microservices architecture, and DevOps practices (CI/CD integration).
- Cloud native apps are modular, scalable and easily deployable; Traditional apps are monolithic and tightly coupled.

Resource Pooling :

It means that cloud providers use multi-tenant model to share computing resources (like CPU, memory, storage, and network) across multiple customers dynamically.

Characteristics :-

- Multi tenancy (resources shared securely among users)
- Dynamic allocation and re-allocation
- Abstracted hardware (users don't know the physical location of resource)

Cloud Infrastructure :

It is foundation on which cloud computing services run. It's made up of hardware and software components that deliver computing power, storage, and networking.

Components -

1. Compute : Virtual machines or containers that perform processing tasks
eg. AWS EC2, Azure VM
2. Storage : Stores data in various forms - objects (S3), block (EBS), or file (EFS)
3. Networking : Connects components and users securely
eg. Virtual networks, load balancers, VPNs
4. Virtualization Layer : Abstracts and manages resources (hypervisor, virtual machine)
5. Management Tools : Automate, monitor, and

orchestrate resources

e.g. AWS CloudWatch, Azure Monitor

6. Security Layer: Ensures access control, encryption, and compliance.

Cloud Networking :

It connects cloud resources (like VMs, storage, and applications) over a virtual network. It enables secure communication between users and services in the cloud.

Components :

- Virtual Private Cloud (VPC)

It isolates and secures cloud resources while allowing custom IP ranges and routing.

- Subnets

- Load Balancers

- Gateways & VPNs (virtual private network)

- Firewalls and network security groups

Cloud Computing Security Controls :

Security controls are safeguards or countermeasures used to protect cloud systems, data, and infrastructure from threats ensuring data confidentiality, integrity and availability.

Types -

1. Preventive : Stop attacks before they happen
e.g. firewalls, encryption

2. Detective : Identify and alert on incidents
eg. intrusion detection systems, monitoring
3. Corrective : Recover from incidents
eg. backups, disaster recovery

- Cloud Elasticity - Ability of the cloud to automatically increase or decrease resources based on current demand.
It supports auto-scaling (up/down), key for cost efficiency, common in IaaS and PaaS environment.
- Cloud Scalability - Capability to handle increased workload by adding resources manually or automatically.
Types :
 - Vertical (Scale Up) : adding more power to an existing machine
 - Horizontal (Scale Out) : adding more machines/nodes.
- Cloud Multitenancy - Architecture where multiple users (tenants) share the same application or infrastructure, but their data remains isolated.
It common in SaaS (e.g. Gmail, Salesforce), ensures data isolation and efficient resource use, and each tenant's experience is independent.

Grid Computing :

- It combines resources from multiple computers often geographically distributed to solve large scale computational problems.
- Works like a distributed system but focuses on resource sharing for a single large task.
- Used in scientific research, simulations, and analytics.
- It is focused on distributed computing power for a task, cloud focuses on delivery on demand service over the internet.

Edge Computing :

- It processes data closer to the source (IoT devices, sensors) instead of sending everything to the central cloud.
- Real time data processing
- Reduces latency and bandwidth usage
- Enhanced reliability for IoT and AI applications
- Edge distributes it closer to devices, cloud centralizes processing.

Eucalyptus :

- Cloud Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems) is an open source platform used to build private and hybrid clouds compatible with AWS APIs.
- IaaS platform for private clouds, compatible with EC2 and S3 APIs, supports virtualization using Xen or KVM.

Everything as a Service (XaaS)

- Any service delivered over the internet instead of locally.
- It extends IaaS, PaaS, and SaaS to include all types of services.
- DBaaS : Database as a Service
eg. Amazon RDS

FaaS : Function as a Service

eg. AWS Lambda

BaaS : Backend as a Service

eg. Firebase

SaaS : Storage as a Service

eg. Google Cloud Storage

- It promotes flexibility, scalability, and cost reduction by allowing users to pay for only what they need.

Container as a Service (CaaS)

- Provides a container based virtualization platform that allows users to manage, deploy and run containers using orchestration tools like Kubernetes or Docker Swarm.
- Sits between IaaS and PaaS, provides scalability, portability, and faster deployment.
- Examples : AWS Fargate, Google Kubernetes Engine, Azure AKS

Microservices

- It breaks an application into small, independent services, each responsible for a single business function (e.g. payment, user, inventory)
- They communicate through APIs (usually REST or gRPC)
- Each microservice can be developed, deployed, and scaled independently.
- Encourages CI/CD and fault isolation
- Works great with containers and cloud native apps.

Service Oriented Architecture (SOA)

- An architectural model where services are reusable components that communicate over a network using standardized interfaces
- Services are larger and more tightly coupled than microservices.
- Often use protocols like SOAP or XML
- Used for enterprise integration (ERP, CRM, etc.)

Event Driven Architecture (EDA)

- Design pattern where components communicate through events when something happens, an event is published, and other components react to it.
- Promotes loose coupling and real-time processing
- Common in systems using Kafka, RabbitMQ, or AWS SNS/SQS.
- Great for scalable, reactive, distributed applications.