

## Before cloud computing

A user was needed ~~to~~ a stack of server to store, host and maintain data. Also, the tasks of monitoring and maintenance of servers was job of user only. All of this costed very expensive.

- ① expensive
- ② Troubleshooting problems in this type of infrastructure leads to distract from primary business growing goals.
- ③ Wasting of space is lead when servers are idle due to variance in traffic
- ④ Complexity

## Cloud Computing

Cloud computing is the on-demand delivery of computer system resources like data storage through internet

## Characteristics of cloud computing

- ① On-demand self-service : Allows customers to use cloud computing resources without human interaction. Making it easy and fast. just sign up and buy ~~use~~ cloud services.
- ② Broad network access : As cloud services are accessible over internet it allows users to access it ~~say~~ from anywhere with an internet connection.

⑥ Cloud computing allows multiple administrators to combine and manage resources such as virtual m/c, storage and networking in such a way to provide it to multiple users.

PAGE NO.:	_____
DATE:	_____

⑦ Resource pooling: It involves aggregating and managing computer resources, such as virtual m/c, storage and networking in such a way to provide it to multiple users.

In this sharing of resources is done. Doing this cloud providers can reduce costs, scale resources, achieving resource efficiency.

⑧ Rapid elasticity: cloud resources can be rapidly scaled up or down to meet changing demand.

⑨ Measured fairness: cloud usage is monitored, controlled, and billed based on the resources consumed, providing transparency and cost control for users.

Scalability: cloud computing offers the ability to quickly and easily scale computing resources up or down based on demand. This can be achieved both vertically (increasing the capacity of individual resources, such as upgrading a server with more CPU or RAM) and horizontally (adding more instances of resources, such as additional server instances).

• **Vertical scalability :** cloud providers allow users to upgrade or downgrade the size and power of their virtual machines or resources, enabling them to handle larger or smaller workload as needed. This flexibility is crucial for adapting to changing demands and optimizing resource usage.

• **Horizontal scalability :** cloud environments support the development of multiple instances of resources, such as additional server instances or database nodes, to distribute workload and accommodate increased demand. This horizontal scaling ensures that applications can handle higher traffic volumes or processing loads efficiently, without being limited by the capacity of a single resource.

## \* Computing paradigm / Evolution of cloud-computing

① **Distributed computing :** In this model computation is spread across multiple interconnected computers or systems.

**Advan** - 1) Decentralization 2) communication 3) error / fault in any node can be tolerated

6) Resource sharing 4) <sup>high</sup> Scalability 5) Parallelism / high throughput

**Disad** - 1) Complex to deploy 2) latency as nodes can be far as they reduce response time

3) Network dependency 5) Security

1) Maintaining data consistency

② Mainframe computing: In this model a large, powerful and centrally-managed computers known as mainframes are used to compute user's input data.

Adv- ① Power and scalability

② Reliable & available

③ Security ④ Batch proc.

disad

① High initial investment

② complex / requires professionals

③ Cluster computing: In this model there is interconnected use of multiple computers to work together as a single unit to accomplish computational tasks. Same as distributed but differ in architecture.

Nodes in cluster typically share a common physical infrastructure in a single location forming it a data center and over a high-speed LAN. While distributed comp. involves multiple computers that are geographically dispersed, such as connected with internet.

Adv- ① Parallel proc - task divided in subtasks to complete it fast.

② strong interconnectivity

disad ① Complexity ② Cost

③ Single point of failure

④ Grid Computing: Similar to distributed computing, grid comp. use heterogeneous and geographically not in distributed.

dispersed computers connected via network to solve complex problems; high computational

- Advantages
- ① Heterogeneity  
While distributed computing have homogeneous or similar hardware and software platform, OS's, and network infrastructure; Grid computing use heterogeneous or diverse hardware and soft w platform, OS's, network infrastructures, capacity, performance, etc.
  - ② Virtual organizations.

While resources are shared and managed by individual organizations or entities in distributed compu. grid compu. has feature of shared and coordinated multiple administrative domains or organiz.

- ⑤ Utility computing : In this computing the service provider provides the needed resources and services to the customer and charges them depending on the usage of these resources as per requirement. typical example is (metered basis) charges are applied for electricity consumption to you. However, rate may or may not be fixed

Advant - ① Metered Billing

log notes

① Edge computing : In this computing the resources are placed closer to the location where it is needed , often on the edge of the network or closer to the source of data generation (input).

Advantages - ① Local processes run on central server mostly are done by each node itself.

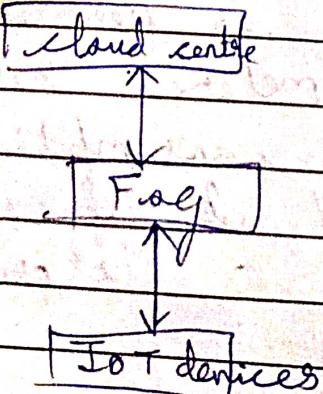
② Reducing latency good for real time response.

③ Reliable

④ Act as a best application for many areas like smart cities, industrial automation, healthcare and IOT .

⑤ Fog computing : In this recomputing intermediate computing nodes or resources here referred as fog nodes are put between edge devices and centralized data centers.

Advan - More enhanced version of adm. than adm. of Edge computing



## Advantages and disadvantages of cloud computing

- ① Scalability
  - ② Cost efficiency
  - ③ flexible
  - ④ easy accessible
  - ⑤ Reliable
  - ⑥ Availability
  - ⑦ Security
  - ⑧ Integration with third party
- Dic.
- ① Security & privacy
  - ② Dependency on service provider
  - ③ Latency and performance

Cloud computing services are typically categorized into three main levels:  
or the three types of service models are:

Service model :- It refers to the specific way in which computer resources and capabilities are delivered to users.

### ① Infrastructure as a Service (IaaS)

IaaS provides virtualized computing resources over the internet. Users rent virtual machines, storage and networking components on a pay-as-you-go basis.

Also these offer self-service for selecting the type of resource ~~you want like~~ which OS, which type of CPU, etc.  
Users can scale up or down on required basis.

The cloud providers manage the infrastructure, while users are responsible for managing OS, applications and data.

Ex - Amazon Web services E C2, Google compute Engine, Microsoft Azure Virtual machines

## ② Platform as a Service (PaaS)

It provides a platform allowing customers to develop, run and manage their applications.

It typically includes development tools, middleware, and runtime environments.

The Application and its related things, and data is managed by user while rest other things are managed by service provider.

Ex - Google App Engine, Microsoft Azure App Service, AWS Elastic Beanstalk

## ③ Software as a Service (SaaS)

It delivers software applications over the internet on a subscription basis.

The all other things are managed by service providers.

Ex - Salesforce (CRM), Microsoft office etc

Service providers

using IaaS model gives :- VMs (Virtual machines),

containers and serverless block storage, object and file storage, virtual networks, load balancers, firewalls, access authority, encryption, managed process of managing databases.

Service provider

using PaaS gives :- All above mentioned services, integrated development environments (IDE), code repositories and CI/CD pipelines, middleware (program for communicating b/w applications or fetching data from database for application), business intelligence, Application hosting.

Service provider

using SaaS gives :- Communication tools like Email, CRM, ERP, CMS, etc.

\* Five core technologies / ideas that played important role in cloud computing.

- distributed systems.
- virtualization
- Web 2.0
- Service-oriented computing
- Utility computing.

\* Autonomic computing (Self Repairable)

The systems capable of self-management, self configuration, self optimization and self healing without human intervention

\* Load balancing

It is a technique used in computing to

distribute incoming network traffic or computational workload across multiple servers, resources, or network links.

## \* Deployment Model

### ① Public cloud

Deployed by third party cloud service providers for public.

Generally cost-effective

Accessible from anywhere with an internet connection

globally availability may raise security & privacy concerns.

May be low depends on resource type and sharing

Example use cases include web hosting, SaaS, new enterprise, etc.

### ② Private cloud

Deployed by a service provider for a single organization.

expensive due to infrastructure

Enhanced security and privacy is present

Dedicated resources for solving critical problem with high predictable and precise solution.

Example use cases include government agencies, financial institutions, healthcare, etc.

Performance  
& per-d  
ficiency

Example  
Who  
we

## Hybrid Cloud

It combine elements of both public and private clouds, allowing to gain benefits of both deployment models.

Workloads can be deployed based on factors such as security, performance, cost, etc.

This provide flexibility, scalability and interoperability.

This architecture require robust networking, connectivity and management capabilities to ensure seamless integration and consistent performance.

Example use cases include diverse workload req., disaster recovery site, and data sovereignty.

## Community cloud

Multi cloud refers to the use of multiple public cloud providers to deploy and manage services.

## Client Server Architecture

**def.** A network architecture where clients request services from a centralized resource.

**Owne**rship organizations

**Resource** sharing limited

**latency** depends

**Infrastru**cture Manage organizations individually

**Cost** different for diff organiz.

**Access**: depends on the network of the server.

**Data Storage**: data → stored in servers, lead → data concentration

**Security**: organizations individually

**Use Cases**: common in traditional applications with a centralized data or service structure

## Cloud Computing Architect.

A distributed model for residing on-demand resources, and services over the internet.

CSP

high

depends

CSP

Pay-as-you-go, usage

Internet

CSP

versatile, suitable for a wide range of applications, from simple web apps to complex analytic

# NIST cloud computing reference Architecture

