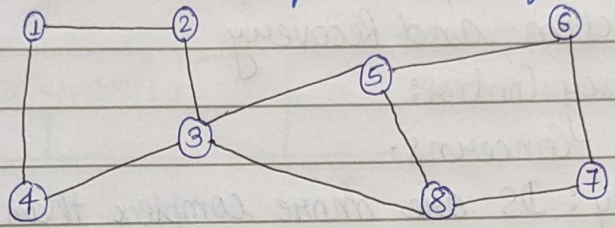
UNIT: 1

Dashrath Nandan

☆ Distributed System :

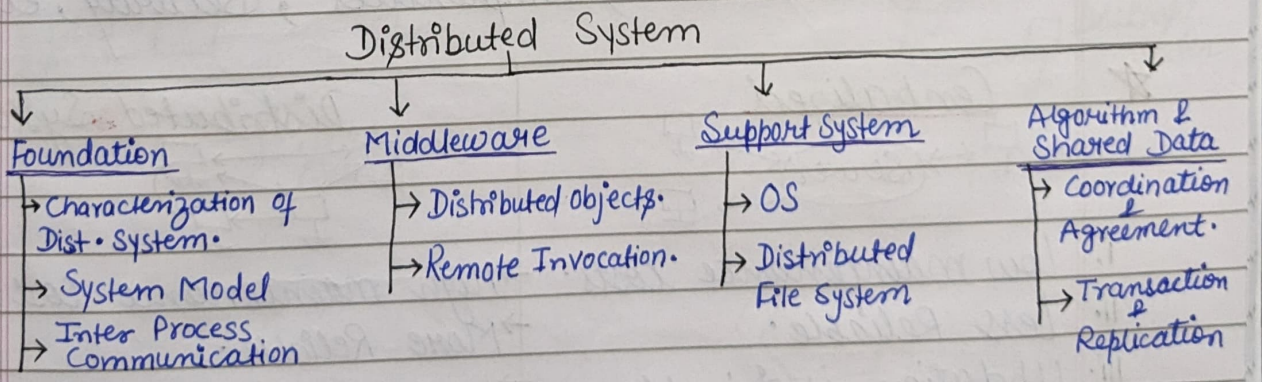
A distributed system refers to a collection of independent computer that works together to provide a unified computing device. These computers are often reffered as nodes.



Nodes are processes, and edges are communication channel.

* History of Distributed Computing :

1940: The British Government came to ~~colt~~ that 2-3 computer will be enough.
1960: Mainframe Computer took up 100 sq. feets.
1970: First LAN, such as Ethernet.
1980: First network cards for PCs.
1990: First WAN, the Internet.



* Key Characteristics :

I. Scalability: Handle an increasing user or task by adding resources.
II. Fault Tolerance: Continue operating despite failure of components.
III. Hetrogeneity: Use of diverse hardware, software & platforms.
IV. Concurrency: Multiple component working simultaneously.

* Challenges in DS:

- Communication delays: Designing for low-latency is essential.
- Consistency and Replication: Achieving consistency in a system with replicated data is challenging.
- Fault Detection and Recovery
- Concurrency Control:
- Security Concerns.
- Complexity: DS are more complex than centralized system.

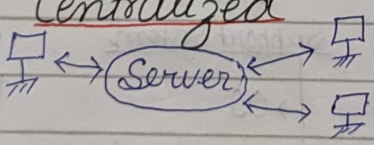
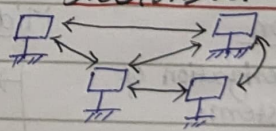
* Advantages of DS:

I. Data Sharing: Allow many user to access a common database.
II. Resource Sharing:
III. Communication: Enhance human-to human comm^{n}. eg. Email.
IV. Flexiblity, Reliablity: If one node failed, system still work.

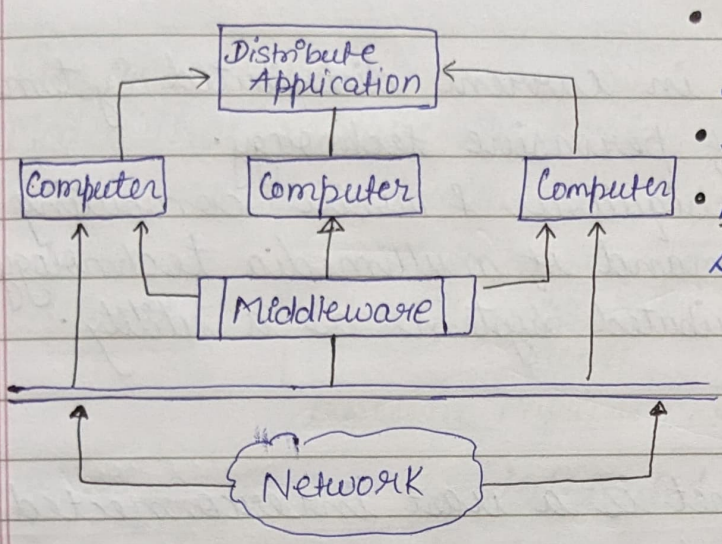
* Disadvantages of DS:

- Network reliance, • complexities, • Security, etc.

*

Centralized 	Distributed System. 
i. Low maintenance costs.	→ High maintenance cost.
ii. Less Reliable.	→ More Reliable.
iii. Updation is simple.	→ Updation is more complex.
iv. Fault tolerance is low.	→ Fault tolerance is high due to absence of single point of failure.

☆ Example of Distributed System:

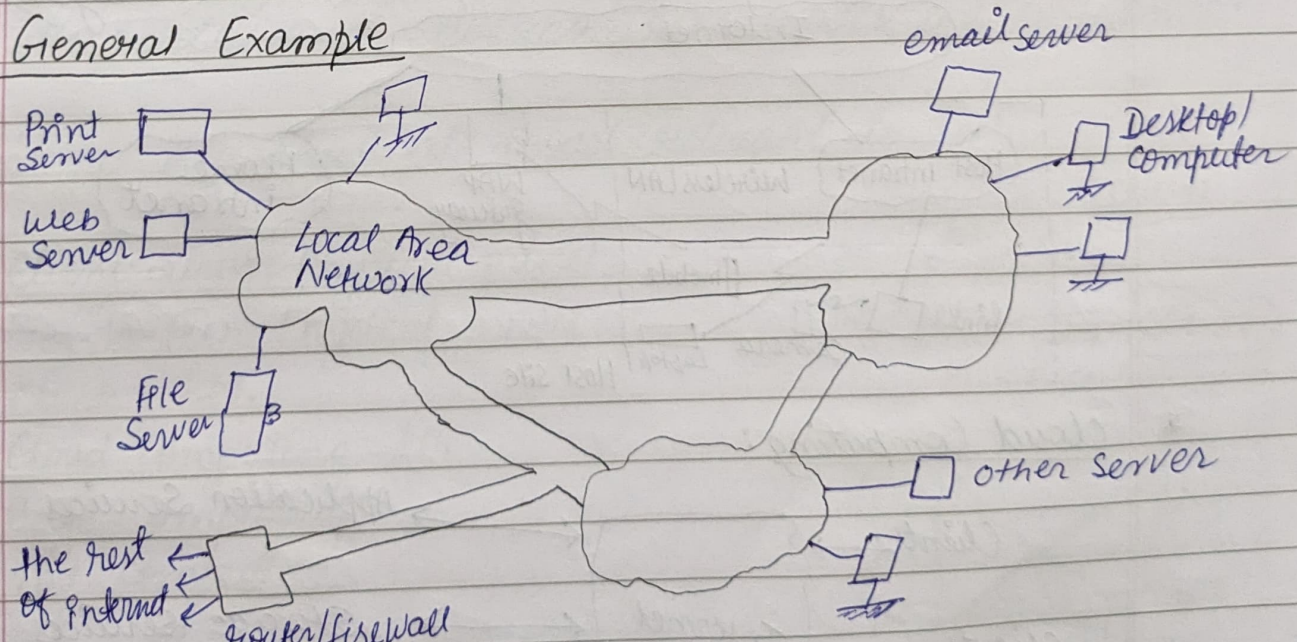


- Distributed System Software, enables computers to communicate.
- Database, store procesed data.
- Middleware, Service enables services by acting as Interface between Centralized & Local System

* Application Area of DS.

- Finance and Commerce: Amazon, eBay, Online Banking, etc.
- Information Society: Serch Engines, Cloud Computing, etc.
- Cloud Technologies: AWS, Microsoft Azure, etc.
- Healthcare, Education, Transport: GPS, Google Maps.

* General Example



☆ Trends in DS:

Significant changes in current distributed System:

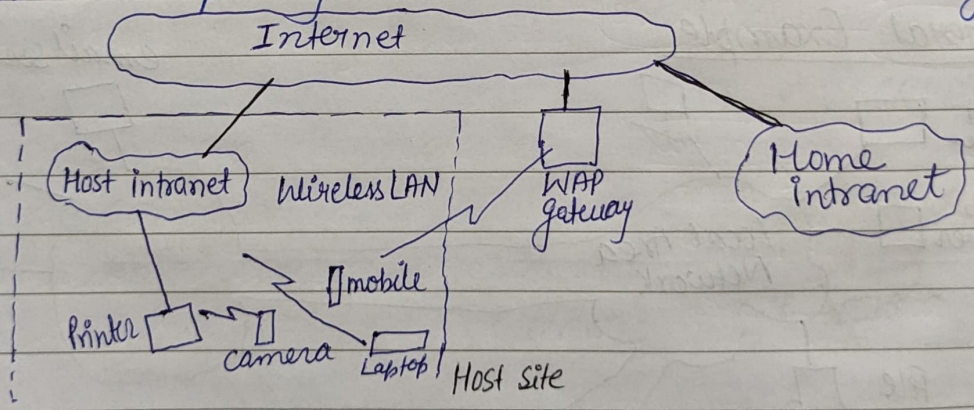
↳ The emergence of pervasive technology.
↳ The emergence of ubiquitous & mobile computing.
↳ The increasing demand of multimedia technology.
↳ The view of distributed system as a utility.

* Internet:

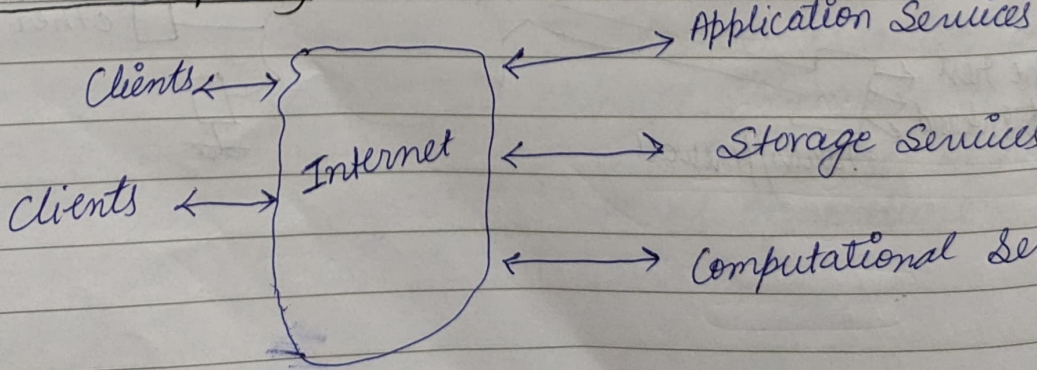
The modern internet is a vast interconnected collection of computer networks of many different types.
The internet is also a very large distributed System.
WWW, email, etc.

* Mobile and Ubiquitous Computing:

Technological advance in device miniaturization and wireless networking led to integration of small and portable computing device into distributed system.



* Cloud Computing:

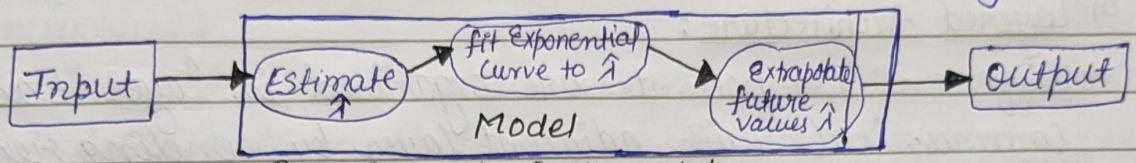


☆ System Models — Physical, Architectural & Fundamental models.

A physical model represents the underlying hardware elements of a distributed system.

1. Physical Model:

Model that capture the hardware composition of a system in terms of computer and their interconnecting networks.



Baseline Physical Model

* Three generations of distributed systems:

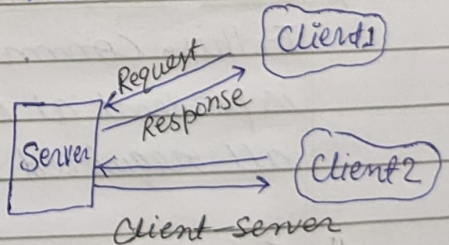
i) Early distributed System: These systems consists of 10-100 Nodes interconnected by a local area network, limited connectivity.

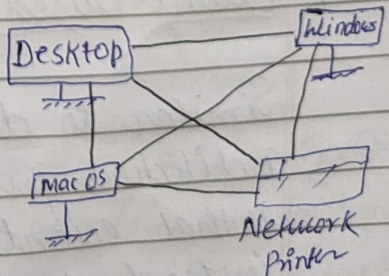
ii) Internet-scale DS: CORBA — The dramatic growth of Internet, large scale ds. started to emerge. An extensible set of nodes interconnected by internet.

iii) Contemporary DS: The emergence of cloud computing discreate and autonomous nodes are embedded.

* Some key physical model relevant to DS:

1. Client-Server Physical model
2. Peer-to-Peer Physical model
3. Cluster P.M.
4. Cloud Computing PM
5. Edge Computing
6. Fog Computing





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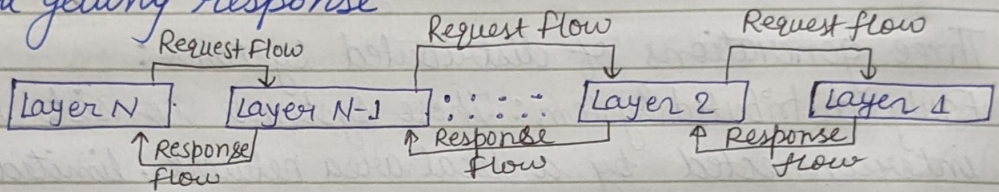
2. Architectural Model:

Architectural model refers to high-level structure and organization of components, modules and their interaction within the system.

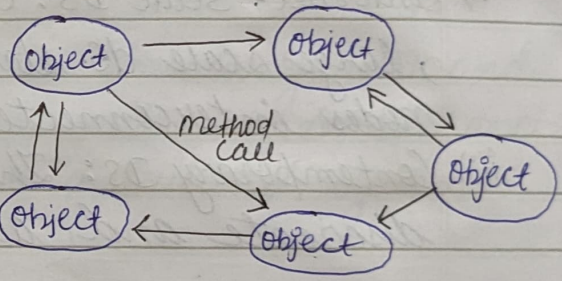
a) Layered Architecture:

Different components are organised in layer. Each layer communicate with adjacent layer by sending request and getting response.



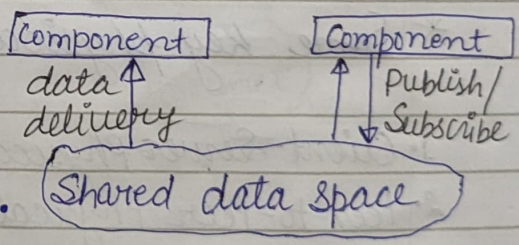
b) Object-Oriented Architecture:

In this, Components are treated as object which convey info. to each other. It is an arrangement of loosely coupled object.



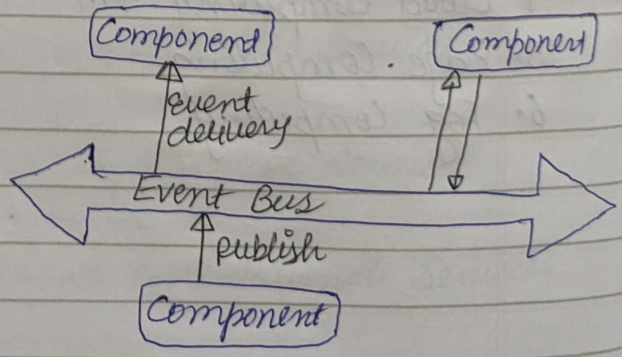
c) Data Centered Architecture:

In this, common data space is persent at center, contains all required data in one place.



d) Event-Based Architecture:

Similar to data-centered architecture just difference is that event is present instead of data.



3. Fundamental Models:

Fundamental models are concerned with a more formal description of the properties that are present in distributed architecture.

Including:

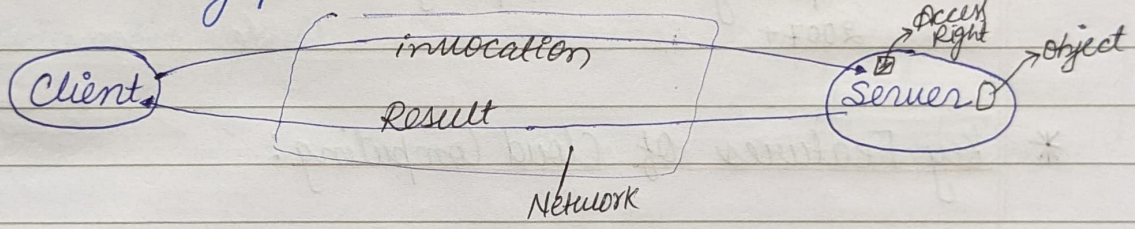
a) The interaction model: deals with performance and difficulties of setting time limit in a distributed system.

Performance Consideration:

Latency – delays between transmission start and its receipt.

Bandwidth – amount of info. that can be transmitted.

b) Failure model: Specification of faults that can be exhibited by process and communication channels.



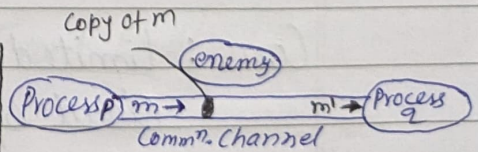
↳ Omission and arbitary failure ↳ Timing failure

↳ Masking failure: A services makes a failure by hiding it.

c) Security Model: Discuss possible threats to processes and communication channels.

Security threats :–

- Enemy – Unauthorized Connec^{n} to Network.
- Threat to process – client or server cannot determine identity.
- Threat to Comm^{n} Channels – enemy can copy or alter or inject msg.
- Denial of Service.



Defeating Security Threat:

↳ Encryption using Cryptography.

↳ Authentication of Sender.

↳ Secure channel.

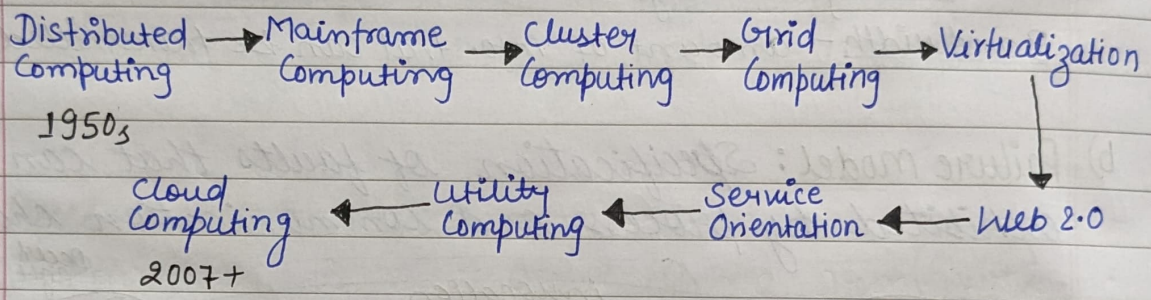
Cloud refers to a network or internet.

☆ Cloud Computing

Cloud Computing refers to manipulating, configuring, and accessing the application over the internet.

→ John McCarthy is known as Father of Cloud Computing.

* Evolution of Cloud Computing:



* Key Features of Cloud Computing:

↳ Resource Pooling, On-Demand Service, Large Network Access
Easy maintenance

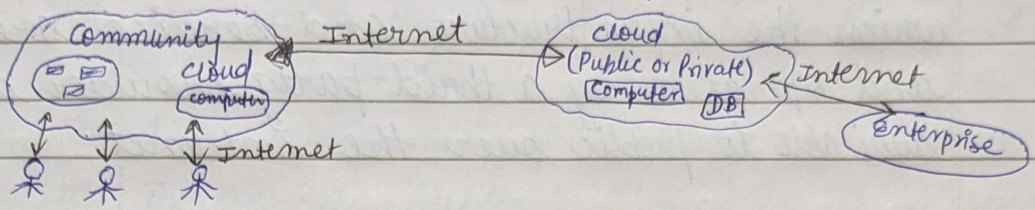
Advantages: Cost Saving, Unlimited Storage, Flexibility
Scalablity, Reliablity, Automatic Software update.

Cons: Limited Control of Infrastructure, Restricted Control
Cloud specialized skills, Rigid Contracts.

* Application:

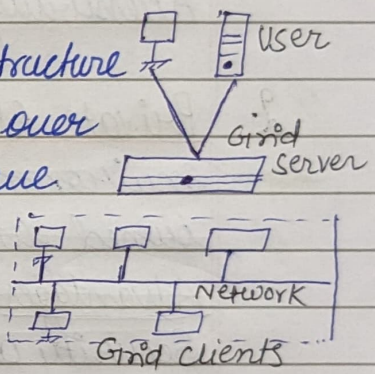
- Online Data Storage
- Backup and Recovery
- Bigdata Analysis
- Testing and development
- Cloud Computing in education and medical fields.

* Community Cloud: A community cloud is a cloud infrastructure in which multiple organisation share resources and services based on common operational requirements.



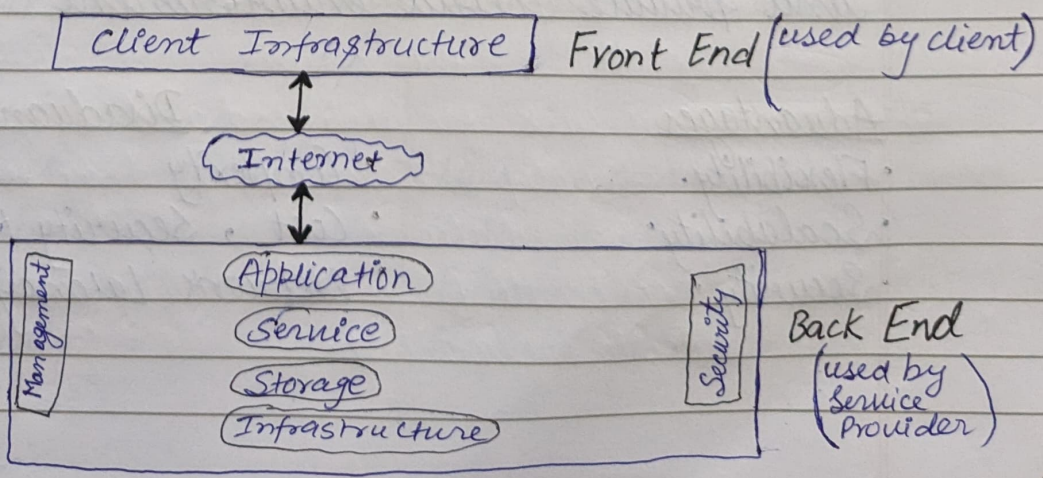
* Utility Computing: Organizations pay for computing they have been used - processing power, network bandwidth, software application. It refers to a business model.

* Grid Computing: Grid Computing infrastructure combines computer resources spread over different geographical locations to achieve a common goal.



* Cluster Computing: Cluster computing describes a network system comprised of homogeneous computer. Homogeneous computer have same hardware and software.

• Architecture of Cloud Computing



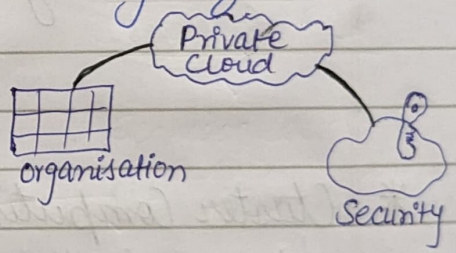
☆ Deployment models of cloud

1. **Public Cloud** : A public cloud is cloud computing in which the infrastructure and service are owned and operated by a third-party provider and made available to public over the internet.

Advantages	Disadvantages
• Cost Efficient	• Security and privacy concern.
• Automatic Software Updates	• Service Downtime.
• Accessibility	• limited control over resource & infra.

2. **Private Cloud** : A private cloud is a cloud computing environment in which infra. and service are owned and operated by a single organization.

Advantages:
Security and Privacy.
Customization of Service.



Disadvantages:
• Higher Cost , Limited Scalability , Maintenance.

3. **Hybrid Cloud**: It is a combination of both public and private cloud environment.

Advantages	Disadvantage
• Flexibility.	• Complexity
• Scalability.	• Cost , Security Risk.
• Security.	• Network Latency.

Factors	Public Cloud	Private Cloud
1. Resources	Shared among multiple customers.	→ Shared with a single organization.
2. Operated by	Third-party service provider.	→ Specific Organisation.
3. Scalability & Flexibility	More scalability and flexibility.	→ predictability and consistency.
4. Expensive	Less Expensive.	→ More expensive.
5. Availability	The generic public	→ Restricted to a specific organization.

☆ Services offered by cloud

Most cloud computing services fall into five categories:

i) SaaS (Software as a Service): Consumer application
ii) IaaS (Infrastructure as a Service): On demand creation of server resources with root access.
iii) PaaS (Platform as a Service): Primarily for developers.
iv) XaaS (Anything/Everything as a Service).
v) FaaS (Function as a Service).

* Cloud managed Services:

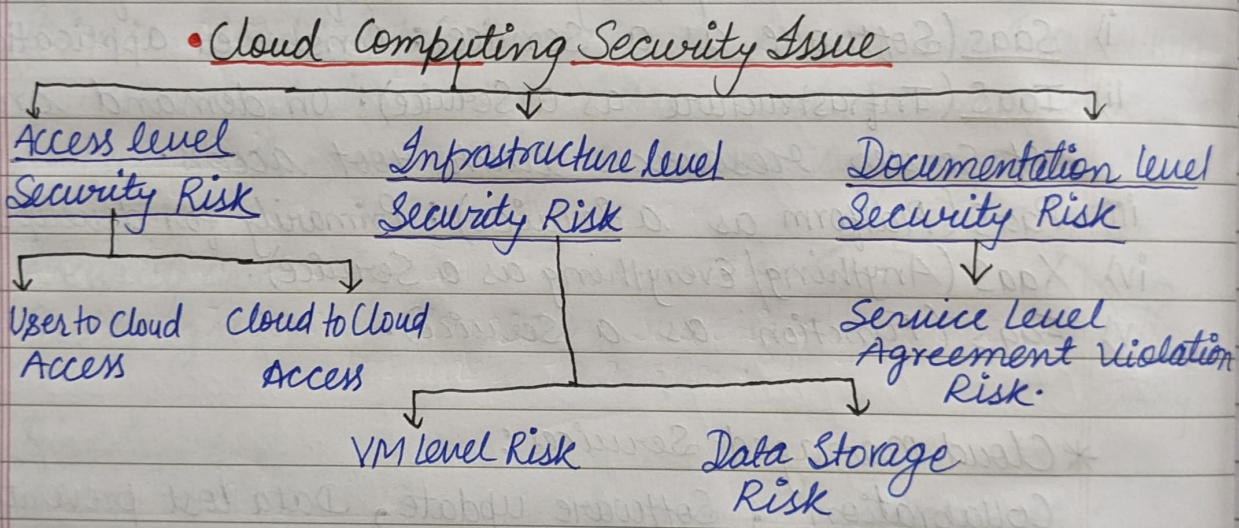
Collabration, Software update, Data lost prevention, Security, mobility, Flexiblity, low cost.

* Pros and Cons of Cloud Storage

Pros	Cons
↳ Disaster Recovery.	→ Lack of Control.
↳ Accessibility.	→ Internet dependent.
↳ Cost-effective.	→ Privacy Concern.
↳ Scalability.	→ Fixed Contracts.

★ Risk Related to Cloud Computing:

i) Data Breaches: The risk of unauthorized access and data breach is a significant concern.
ii) Identity and Access Management (IAM).
iii) Data deletion: Accidental or malicious data deletion.
iv) Dependency on Service provider.
v) Internet Connectivity: Reliance on internet for accessing.
vi) Data Jurisdiction: Different countries have varying data protection and privacy laws.
vi) Uncontrolled viable cost.



* Cloud Risk Assement method and Framework.

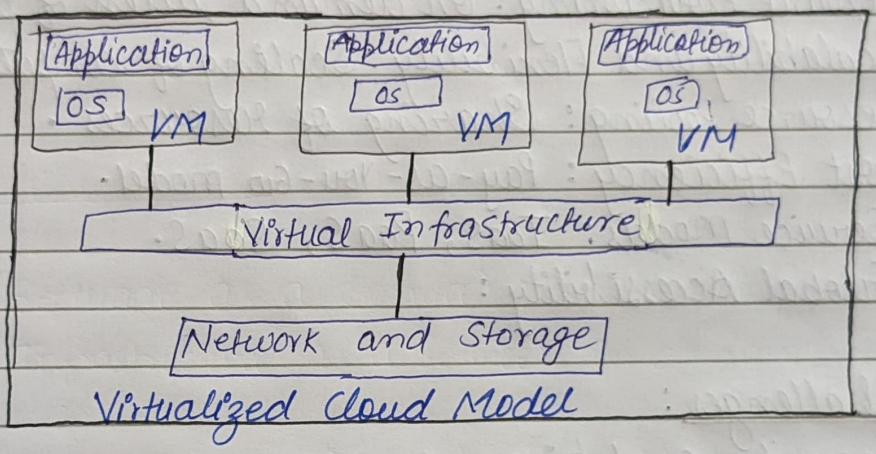
i) Identify: Identify the risk releated to deploying a solution in the cloud.
ii) Assess: Assess risk for likelihood and impact.
iii) Remediate: Develop solution or strategy for risk remediation.
iv) Plan: Incorporate final risk rating into cloud adoption planning.

Dashrath Nandan

☆ Virtualization in Cloud Computing:

Virtualization is the "Creation of a virtual" version of server, desktop, a storage device, an OS, etc.

The machine on which virtual machine is going to create is known as Host Machine and that virtual machine is referred as a Guest Machine.



Virtualized Cloud Model

* Types of Virtualization

1. Hardware Virtualization: When the virtual machine software is directly installed on the hardware system is known as hardware virtualization. It is done because controlling VM is easier than controlling a physical server.

2. Server Virtualization: Virtual machine software -or Virtual machine manager (VMM) is directly installed on the Server system. It is done because a single Server can be divided into multiple Servers on demand basis.

3. OS Virtualization: In this VMM is installed on the Host operating system. It is mainly used for testing the application on different platform of OS.

4. Storage Virtualization: It is the process of grouping the physical storage from multiple network storage device so that it looks like a single storage device. It is done for back-up and recovery purpose.

★ Key Characteristics:

i. Resource Provisioning: On demand access of processing power
ii. Scalability and Flexibility: Scaling of computing resource.
iii. Resource Pooling: Sharing of resources.
iv. Cost Efficiency: Pay-as-You-Go model.
v. Service models: IaaS, PaaS, SaaS.
vi. Global Accessibility:

★ Challenges:

i. Security and privacy concern.
ii. Dependency on internet connectivity.
iii. Vendor lock-in: Challenges in switching from one computing provider to another.

✱ Cloud Computing.	Virtualization
• It provides pools and resources which are automated.	It is used to make simulated environment.
• Set-up can be complicated.	The set-up is simpler.
• Total operational cost are higher.	Operational costs are lower than cloud.
• Unlimited storage space.	Storage space depends on physical server capacity.
• Require many dedicated hardware component.	A single dedicated hardware can do a great job.