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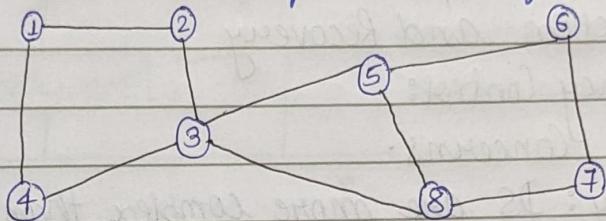
Dashrath Nandan

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* Distributed System :

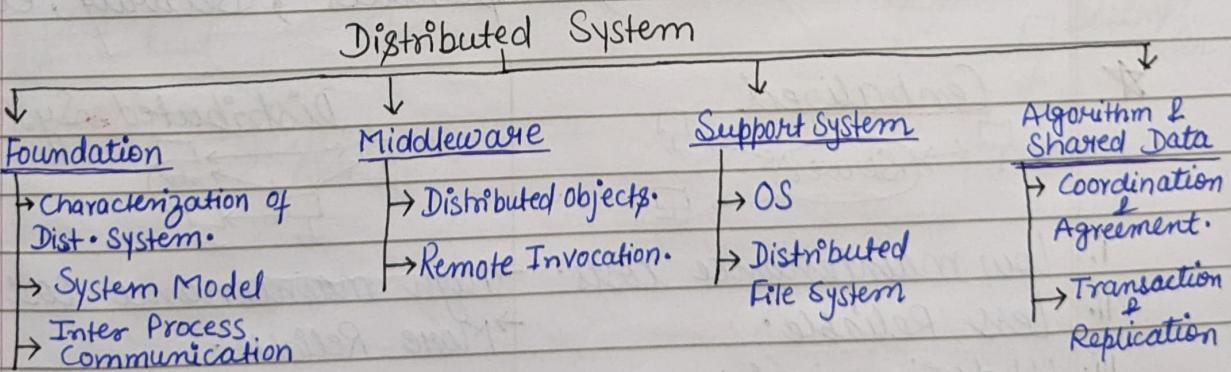
A distributed system refers to a collection of independent computer that works together to provide a unified computing device. These computers are often referred as nodes.



Nodes are processes, and edges are communication channel.

* History of Distributed Computing :

- 1940: The British Government came to conclusion that 2-3 computer will be enough.
- 1960: Mainframe Computer took up 100 sq. feet.
- 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. Heterogeneity: 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.

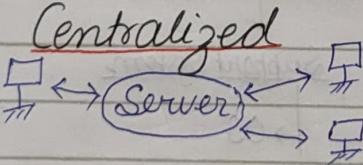
* Advantages of DS:

- I. Data Sharing : Allow many user to access a common database.
 - II. Resource Sharing:
 - III. Communication : Enhance human-to-human commⁿ. Eg. Email.
 - IV. Flexibility , Reliability : If one node failed, system still work.

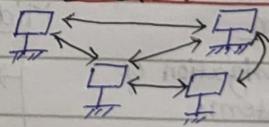
* Disadvantages of DS:

- Network Reliance, complexities, Security, etc.

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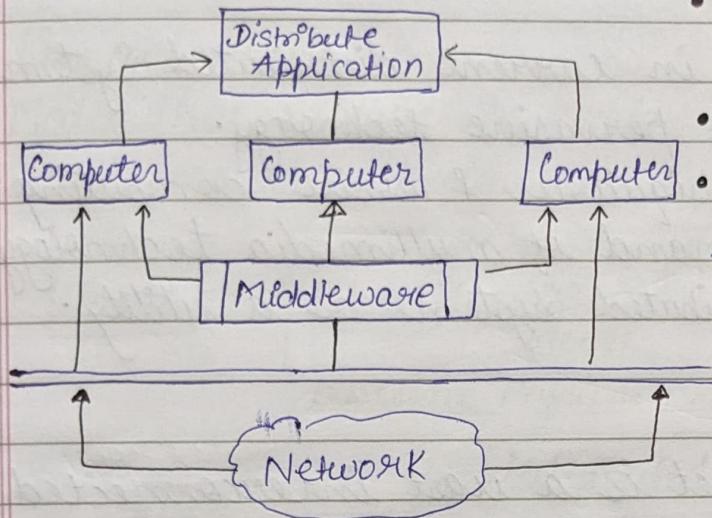


Distributed System.



- | | | |
|------|-------------------------|--|
| 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:

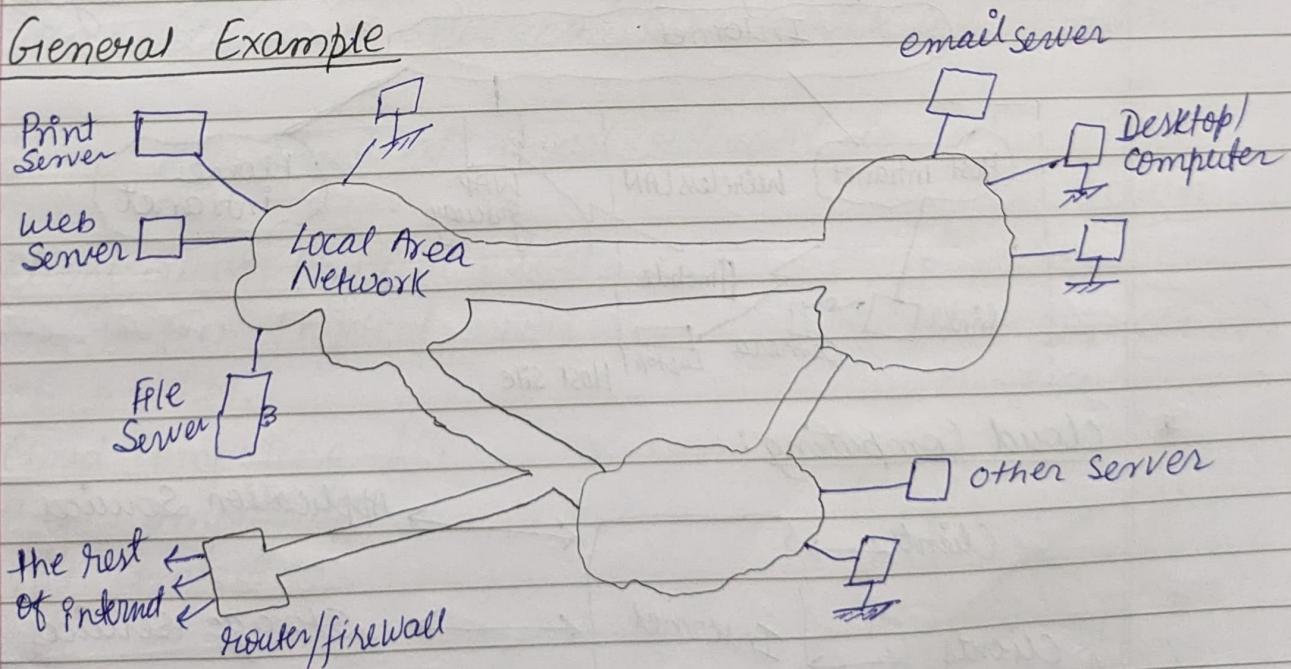


- Distributed System Software, enables computers to communicate.
- Database, store processed data.
- Middleware, service enables services by acting as interface between Centralized & Local System

* Application Area of DS:

- Finance and Commerce : Amazon, eBay, Online Banking, etc.
- Information Society : Search 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:

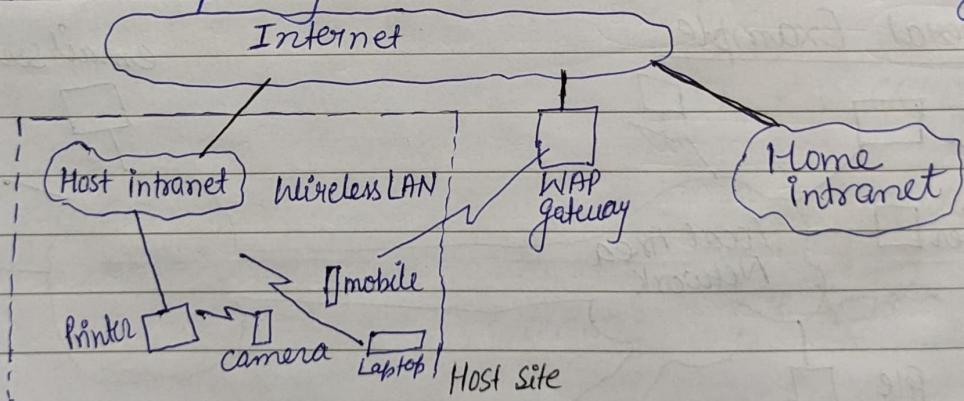
- ↳ The emergence of pervasive technology.
- ↳ The emergence of ubiquitous & mobile computing.
- ↳ The increasing demand of multimedia technology.
- ↳ The view of distributed system as a utility.

* Internet:

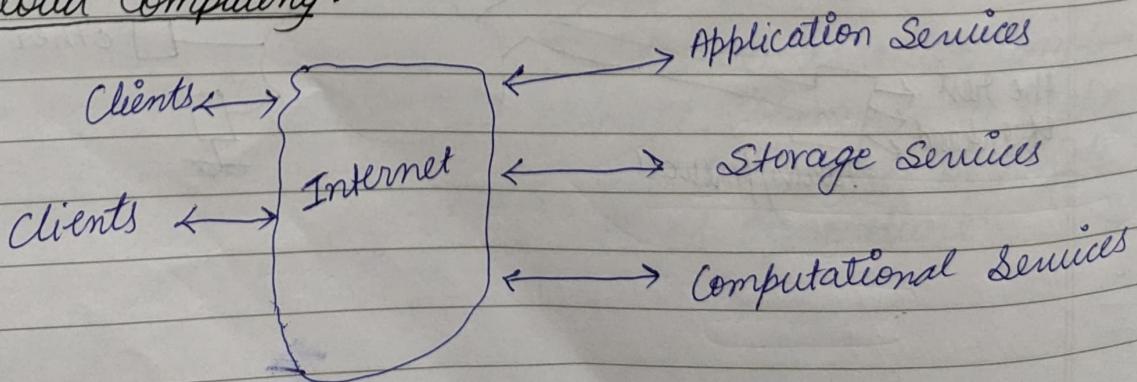
The modern internet is a vast interconnected collection of computer networks of many different types. The internet is also a very large distributed system. www, email, etc.

* Mobile and Ubiquitous Computing:

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



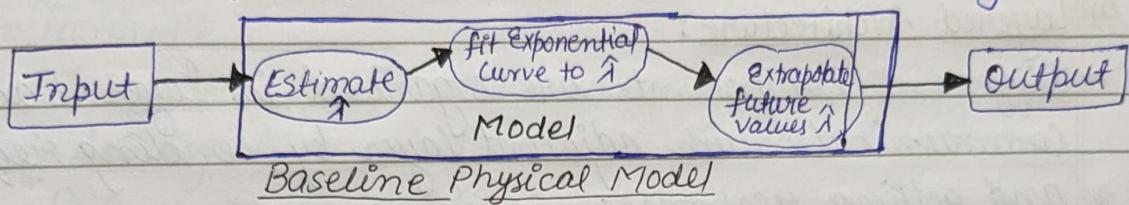
* Cloud Computing:



★ System Models — Physical, Architectural & Fundamental models.

1. Physical Model:

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

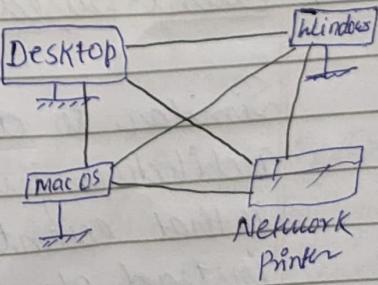
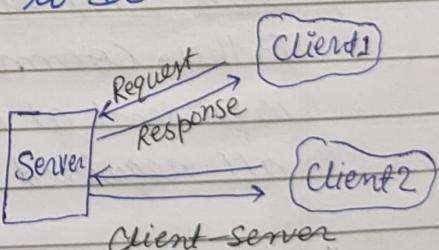


* Three generations of distributed systems :

- Early distributed System: These systems consists of 10-100 Nodes interconnected by a local area network, limited connectivity.
- Internet-scale DS: CORBA — The dramatic growth of Internet, large scale ds. started to emerge. An extensible set of nodes interconnected by internet.
- Contemporary DS: The emergence of cloud computing discrete and autonomous nodes are embedded.

* Some key physical model relevant to DS:

- Client-Server Physical model
- Peer-to-Peer Physical model
- Cluster P.M.
- Cloud Computing PM
- Edge Computing
- Fog Computing



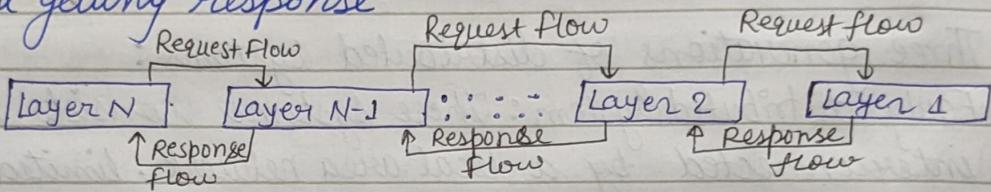
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2. Architectural Model :

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

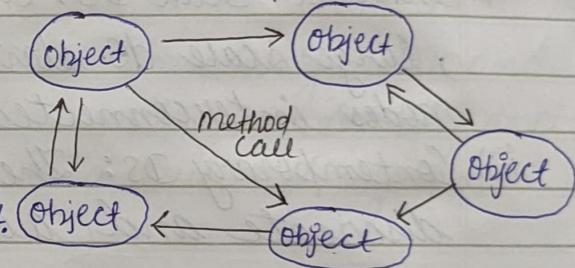
a) Layered Architecture :

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



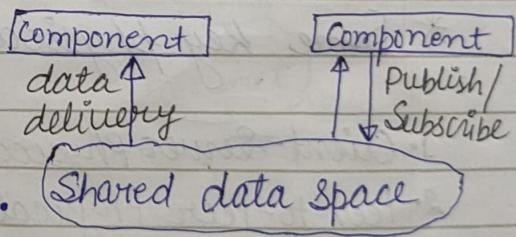
b) Object-Oriented Architecture :

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



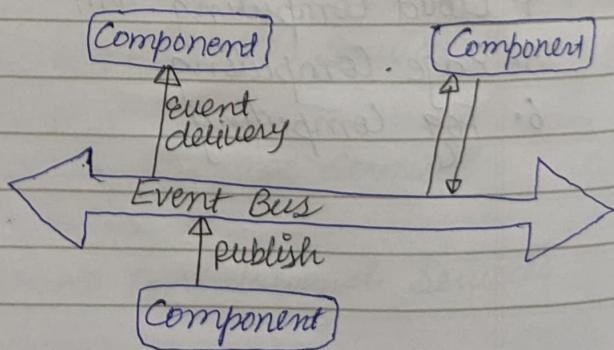
c) Data Centered Architecture :

In this, common data space is present 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:

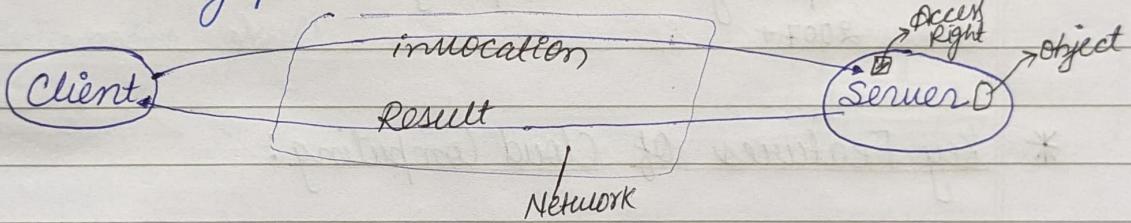
- a) The interaction model: deals with performance and difficulties of setting time limit in a distributed system.

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.



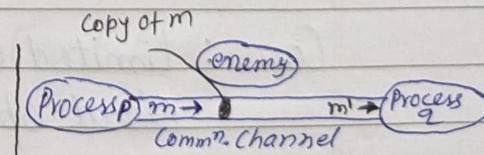
↳ Omission and arbitrary failure ↳ Timing failure

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

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

Security threats :-

- Enemy — unauthorized connect. to Network.
- Threat to process — client or server cannot determine identity.
- Threat to Comm. Channels — enemy can copy or alter or inject msg.
- Denial of Service.



Defeating Security Threat:

- ↳ Encryption using Cryptography.
- ↳ Authentication of Sender.
- ↳ Secure channel.

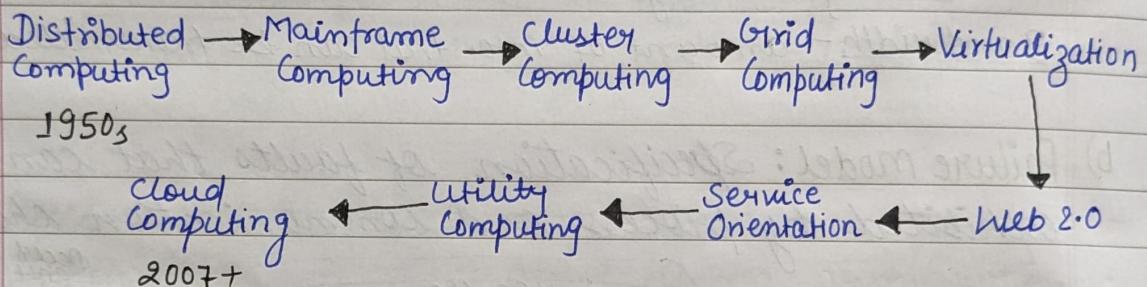
Cloud refers to a network or internet.

* 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

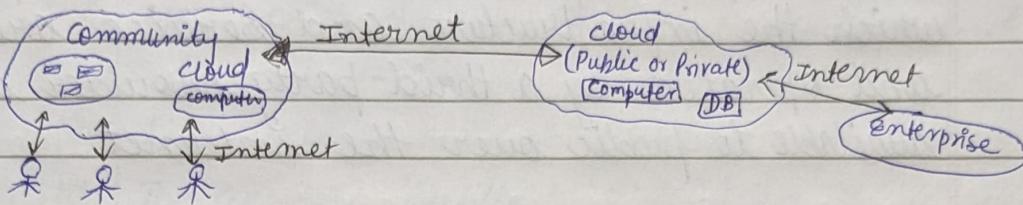
Advantages: Cost Saving, Unlimited Storage, Flexibility
Scalability, Reliability, Automatic Software update.

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

* Application:

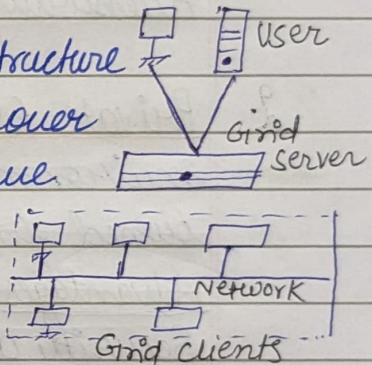
- Online Data Storage
- Backup and Recovery
- Bigdata Analysis
- Testing and development
- Cloud Computing in education and medical fields.

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



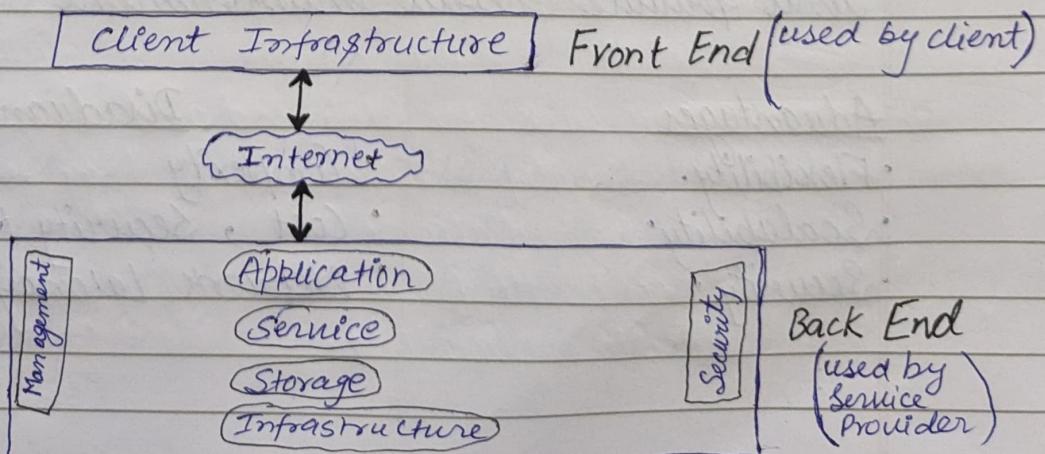
* **Utility Computing:** Organizations pay for computing they have been used - processing power, network bandwidth, software application. It refers to a business model.

* **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 computers. Homogeneous computers 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

- Cost Efficient
- Automatic Software Updates
- Accessibility

Disadvantages

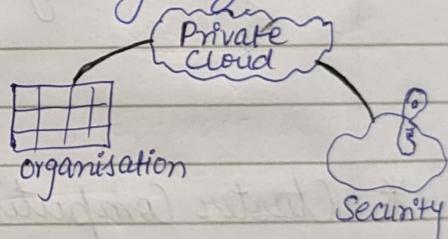
- Security and privacy concern.
- Service Downtime.
- limited control over resource & infra.

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

- Flexibility.
- Scalability.
- Security.

Disadvantage

- Complexity
- Cost, Security Risk.
- Network Latency.

<u>Factors</u>	<u>Public Cloud</u>	<u>Private Cloud</u>
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:

Collaboration, Software update, Data lost prevention, Security, mobility, flexibility, low cost.

* Pros and Cons of cloud storage

Pros

- ↳ Disaster Recovery.
- ↳ Accessibility.
- ↳ Cost-effective.
- ↳ Scalability.

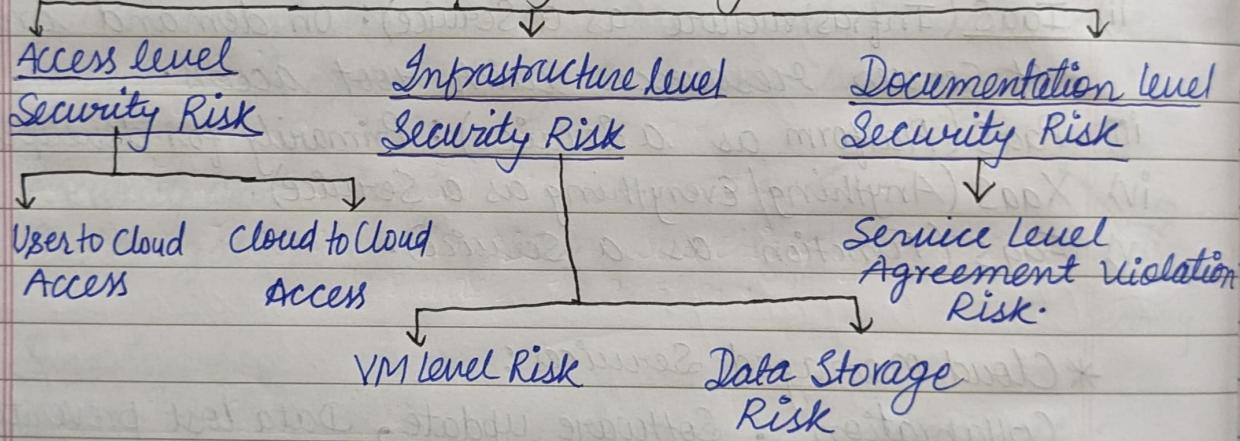
Cons

- Lack of Control.
- Internet dependent.
- Privacy Concern.
- 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 Computing Security Issue



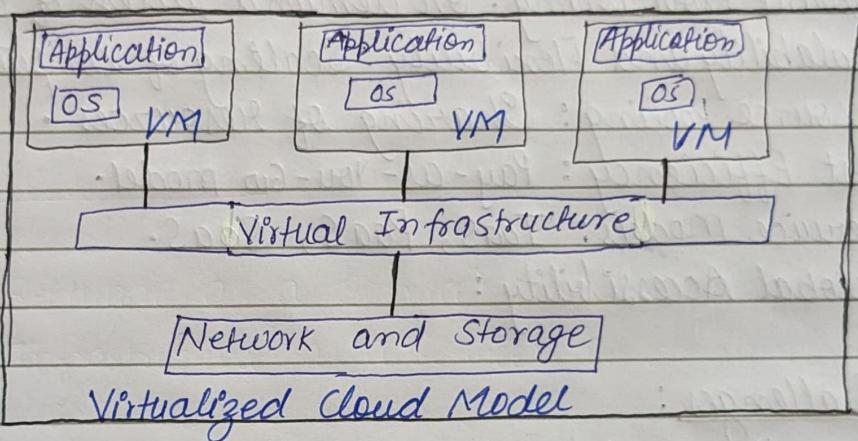
* Cloud Risk Assessment method and Framework.

- i) Identify: Identify the risk related 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.

* 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.



* 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:

- It provides pools and resources which are automated.
- Set-up can be complicated.
- Total operational cost are higher.
- Unlimited storage space.
- Require many dedicated hardware component.

Virtualization

- It is used to make simulated environment.
- The set-up is simpler.
- Operational costs are lower than cloud.
- Storage space depends on physical server capacity.
- A single dedicated hardware can do a great job.

UNIT:2

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

* Cloud Services Models

Most cloud computing services falls into five broad category-

- i) Software as a Service (SaaS).
- ii) Platform as a Service (PaaS).
- iii) Infrastructure as a Service (IaaS).
- iv) Anything as a Service (XaaS).
- v) Function as a Service (FaaS).

1) SaaS : Software as a Service

SaaS is a way of delivering services and applications over the internet. The service provider are providing a complete software or an application in form of service.

Application	Web-base Application		Web Portal	
	General APP.	Business APP	Scientific APP	Government APP
	Commercial Platform	Open Source Platform	Others	

- SaaS Providers : Google Apps, Salesforce.com, Microsoft Office 365

* Advantages:

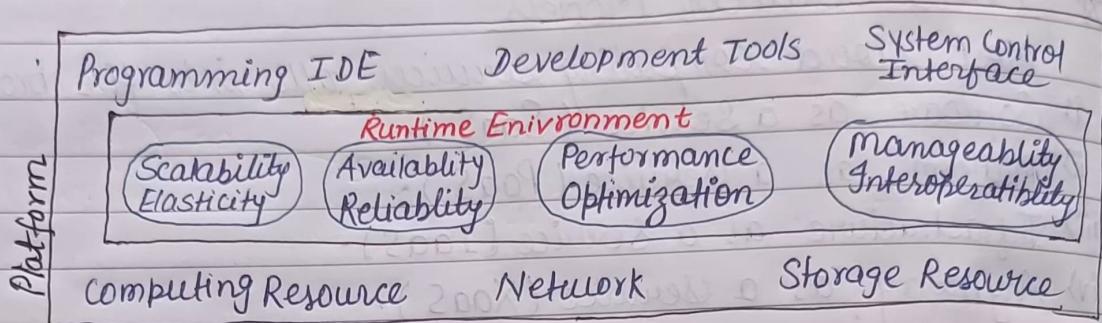
- i) SaaS is easy to buy.
- ii) On-demand service.
- iii) Less hardware required.
- iv) Low maintenance required.
- v) No-client side installation.

Disadvantages

- i) Security.
- ii) Total Dependency on internet.
- iii) Latency issues.
- iv) Switching b/w vendors is difficult.

2.) PaaS: Platform as a Service

PaaS provides a platform and environment to allow developers to build applications and services over internet.



Examples: Google App Engine, Azure

* Advantages

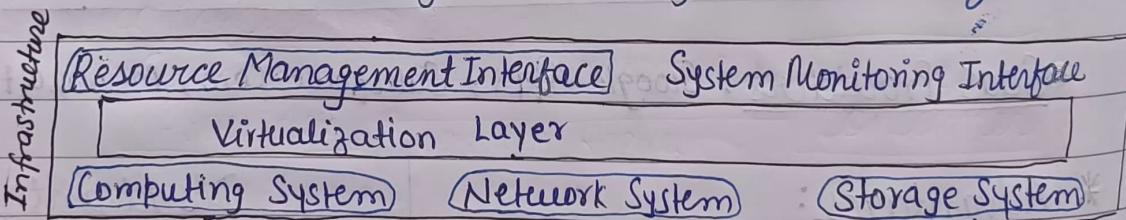
- i) Simplified Development
- ii) Lower risk
- iii) Scalability

Disadvantages

- Vendor lock-in
- Data Privacy
- Integration with Syst. App

3.) IaaS: Infrastructure as a Service

IaaS provides on-demand access to computing resources such as servers, storage, networking and virtualization.



• Benefits: Economical, Efficient, Reliable, Scalable.

* Advantages

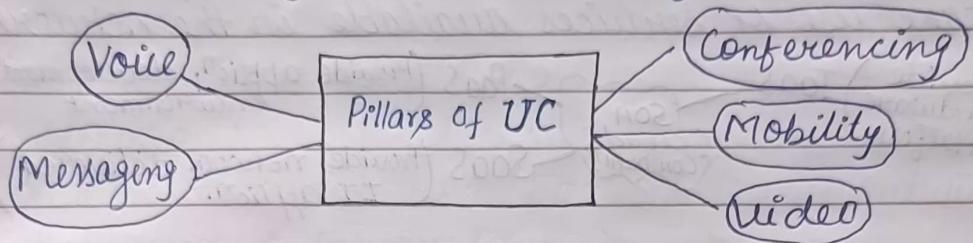
- i) Cost Saving.
- ii) Reliability.
- iii) High Scalability
- iv) Low latency

Disadvantages

- Limited Control over infrastructure.
- Security concern.
- Limited access.

4) Ucaas / FaaS: Unified Communication as a Service.

Ucaas is a cloud delivery model that brings unified communications (UC)-like chat, file sharing, telephony and video conferencing tools- into a single interface or platform.



* Essential function of Ucaas:

- Chat
- Voice
- Video
- Collaboration: file sharing, calenders,

* Features / Advantages

- i) Reduced Cost
- ii) Scalability, Flexibility.
- iii) Improved Productivity
- iv) Support, Security

Disadvantages

- Dependency on internet.
- Limited emergency calling.
- Cost structure
- Loss of control.

* IAAS

- i) Infrastructure as a Service
 - ii) used by network architects.
 - iii) It is highly scalable, and flexible.
 - iv) Provides only Infrastructure.
 - v) It provides access to resources such as VM, V-Storage, etc.
- Cloud Service

PAAS

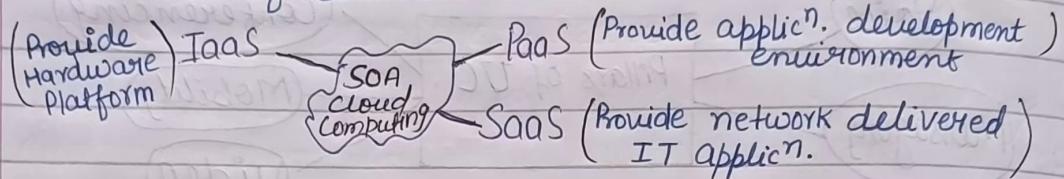
- Platform as a Service
- Used by Developers
- Highly scalable to suit diff. businesses.
- Provide Infrastructure + Platform
- It provides Runtime environment and deployment tools.

SAAS

- Software as a Service
- Used by end user.
- Highly scalable to suit the small, mid businesses.
- Provide Infrastructure + Platform + Software.
- It provides software as a service to end-user.
- MS office web, facebook, Google Apps.

* Service Oriented Architecture (SOA) :

SOA is a stage in the evolution of application development and/or integration. SOA is an architectural approach in which application make use of services available in the network.

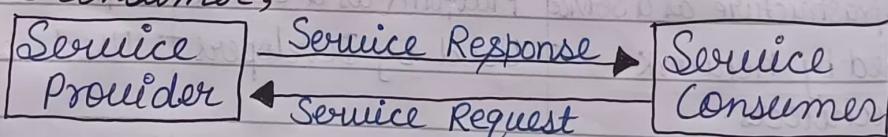


* Characteristic of SOA :

- Provide interoperability between services.
- Provide methods for Service encapsulation.
- Facilitates QoS (Quality of Services)
- Provide loosely coupled services.
- Ease of maintenance.

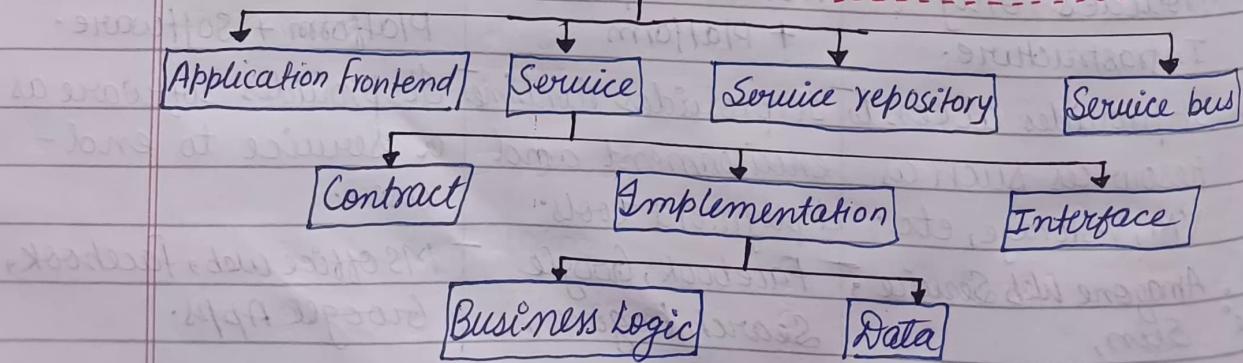
* Two major roles within SOA:-

- Service provider, is the maintainer of the service and organization that make service available to others.
- Service consumer,



* Components of SOA

Service-oriented architecture



* Guiding Principles of SOA:

1. Standardized Service Contract : Specified through service desc. document.
2. Loose Coupling : Services are self-contained component.
3. Abstraction : They hide their logic, encapsulated within implementation.
4. Autonomy
5. Reusability
6. Discoverability
7. Composability

* Application :

- i) SOA infrastructure is used by many armies and air-forces.
- ii) SOA is used to improve healthcare delivery.
- iii) SOA helps maintain museums a virtualized pool for their info.

* Advantages

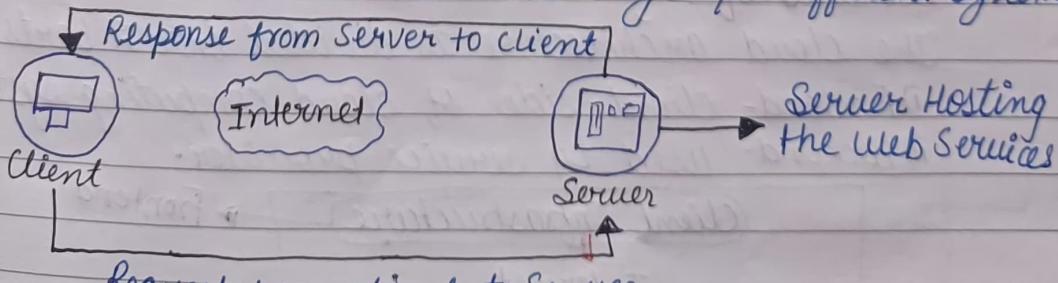
- i) Service Reusability
- ii) Easy maintenance
- iii) Platform independent
- iv) Availability ; Reliability ; Scalability

Disadvantages

- Complex Service management.
- High Investment.
- High Overhead.

* Web Services

A Webservice is a standardized method for propagating message between client and server application on the World Wide Web. It is a set of open protocols and standards that allow data exchange b/w different systems.



- XML and HTTP is the most fundamental web service platform.

* Web Service Components

- 1) SOAP (Simple Object Access Protocol)
It is a transport-independent messaging protocol. It is built on sending XML data in the form of SOAP msg.
- 2) UDDI (Universal Description, Search and Integration)
UDDI is a standard for specifying, publishing and searching online service providers. It provides specification that helps in hosting data through web services.
- 3) WSDL (Web Service Description Language)
The client implementing the web service must be aware of the location of the web services.

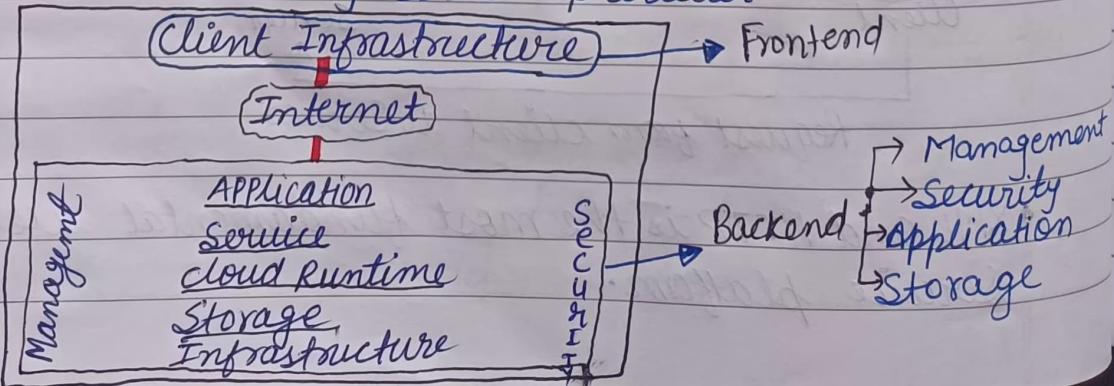
* Features of Web Services:

- XML based: A webservice info. record transport layer employ XML.
- Loosely Coupled:
- Ability to be Synchronous or asynchronous: Synchronicity refers to client's connection.
- Coarse Grain: Object-oriented system, make service available differently.
- Support remote-procedural calls.

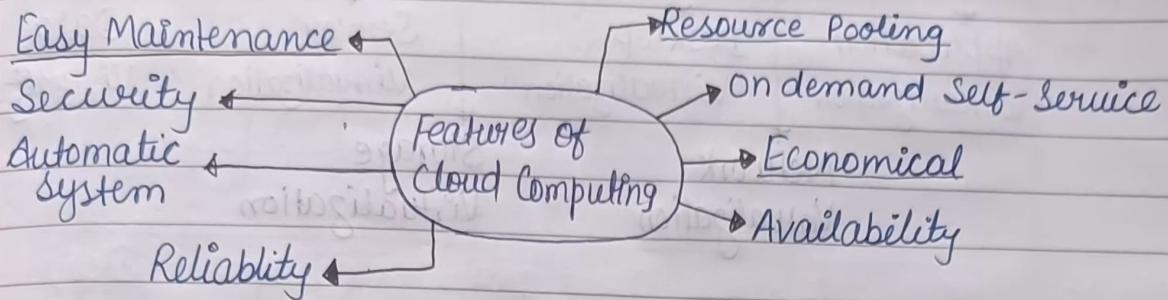
* Cloud Computing Architecture

The cloud architecture is divided into 2 parts i.e.

- i) Frontend - Client-side of cloud computing system.
- ii) Backend - used by service provider.



* Features of Cloud Computing Architecture

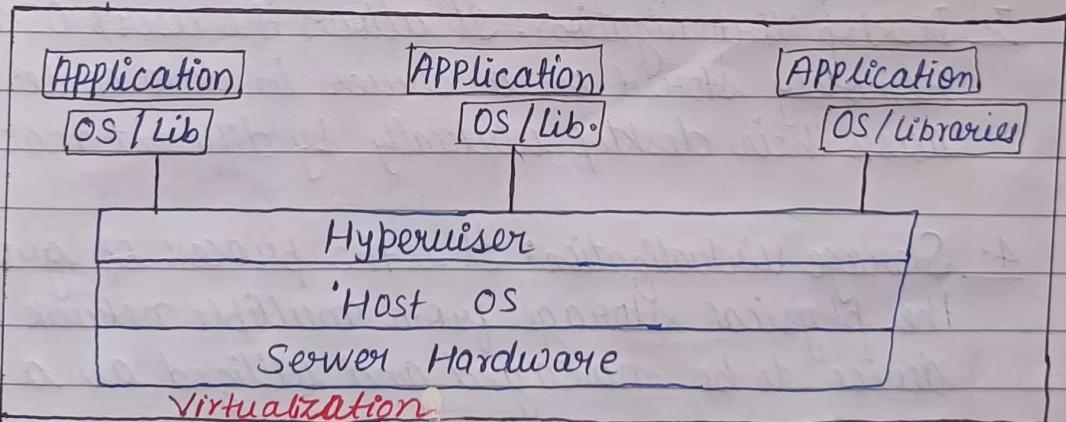


- Make overall cloud computing system simpler
- Improve data processing requirements

* 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.

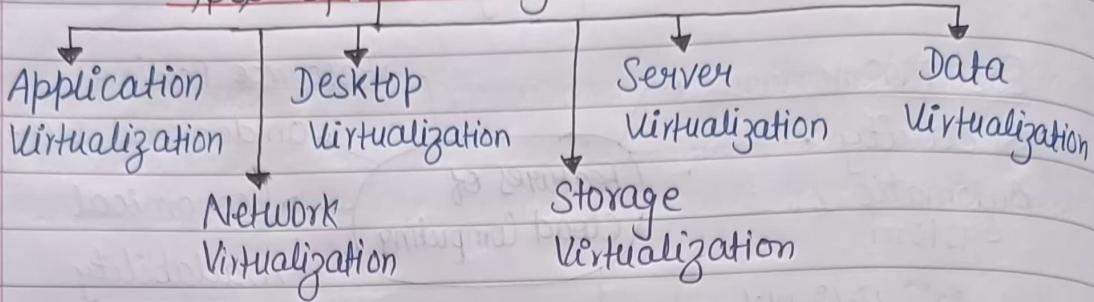


* Key Characteristics :

- Resource Provisioning
- Scalability and Flexibility
- Resource Pooling
- Cost Efficiency
- Service models - IaaS, PaaS, SaaS
- Global Accessibility

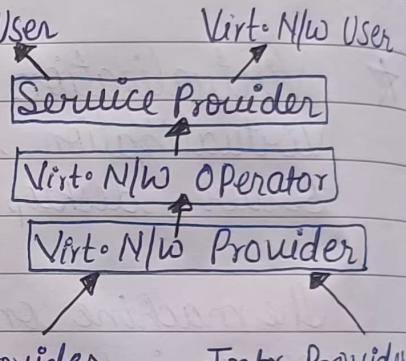


Types of Virtualization



1. Application Virtualization: It helps a user to have remote access to an application from a server. The server stores all the personal info and other charact. of the applic.

2. Network Virtualization: The ability to run multiple virtual networks with each having a separate control and data plan. It co-exist together on top of one physical network.



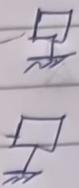
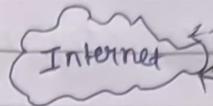
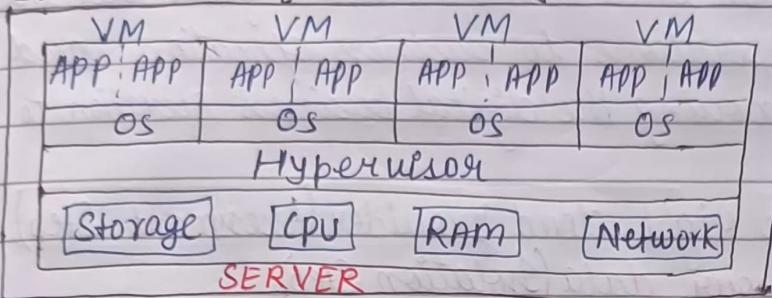
3. Desktop Virtualization: It allows the user's OS to be remotely stored on a server in data center. The user access their desktop virtually by different machine.

4. Storage Virtualization: It is the process of grouping the physical storage from multiple network storage device to be managed and utilized as a single repository.

5. Server Virtualization: This is a kind of virtualization in which masking of server resources take place. Central Server (Physical) is divided into

multiple different virtual servers.

Server Virtualization



6. Data Virtualization: In this, data is collected from various sources and managed at a single place.

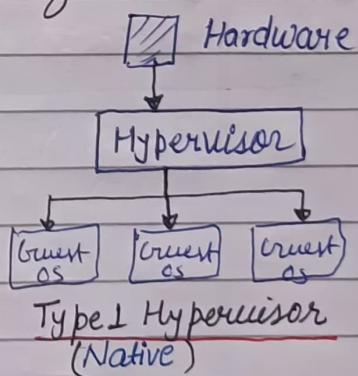
* Uses of Virtualization:

- i) Data - Integration
- ii) Business - integration
- iii) SOA data - service
- iv) Searching organizational data.

* Tools and Products available for virtualization:

* Hypervisor is a form of virtualization software used in cloud hosting to divide and allocate the resource on various pieces of hardware.

Eg:- VMware vSphere, Xen, KVM,



• Desktop Virtualization :- VMware Workstation, Oracle Virt. Box.

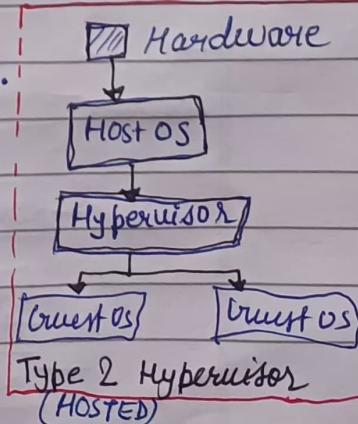
• Application :- Docker, Podman.

• Network :- Cisco ACI, Open vSwitch.

• Storage :- DataCore SAN symphony.

• Cloud management :- OpenStack.

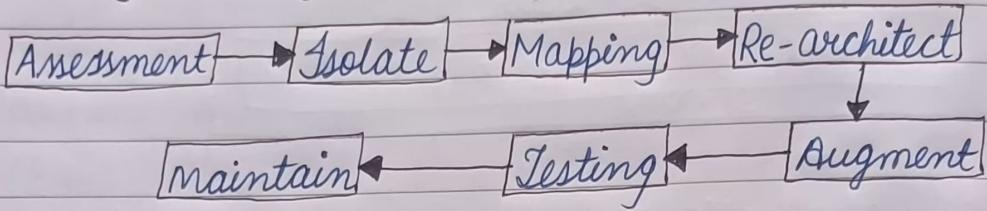
• Backup & Recovery :- Unitrends



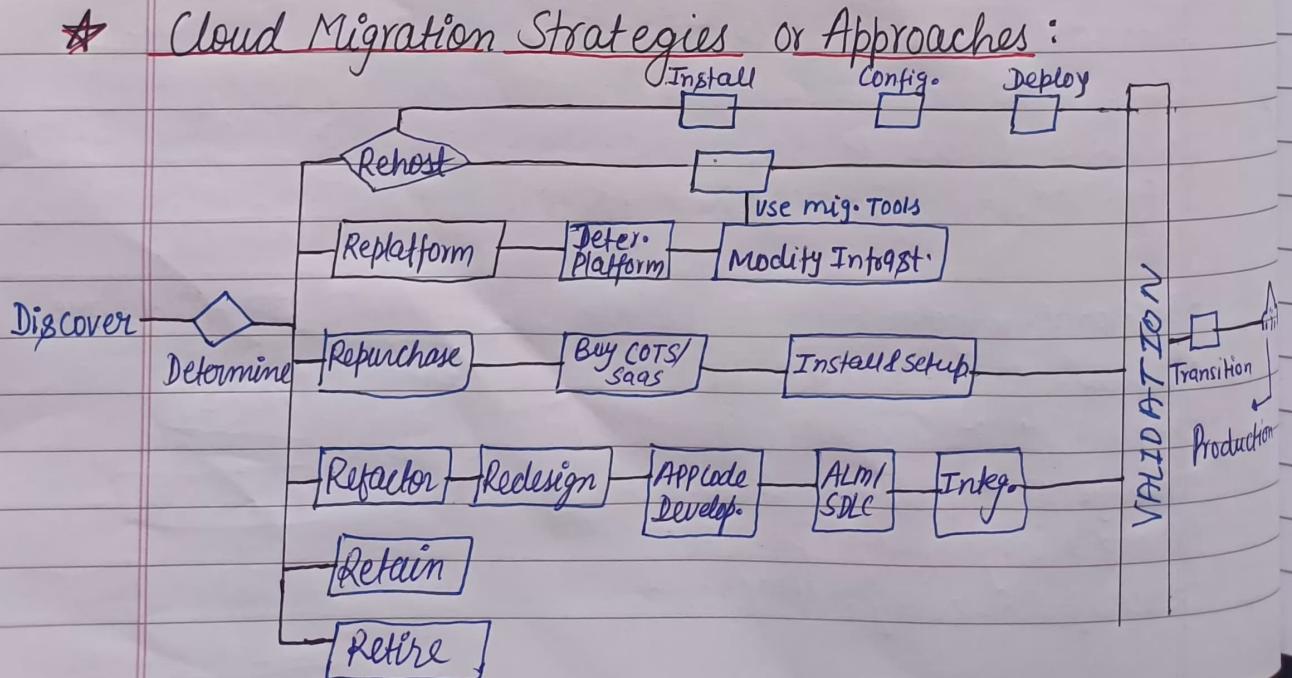


Seven Step model of migration into a cloud

Cloud migration is a transformation from old traditional business operations to business operation and process refers to moving the digital business operation to cloud.



- Step 1: Choose the right cloud provider (Assessment step)
- Step 2: Prepare your data (Isolation step)
- Step 3: Choose your cloud storage (mapping step)
- Step 4: Set up your cloud computing resource and deploy your model (Re-architect step)
- Step 5: Leverage cloud functionalities & features (Augmentation step)
- Step 6: Test your model
- Step 7: Iterate and optimize ; monitor and maintain your model



1. Re-hosting: Also known as "lift and shift". Redeploy existing data and application on the cloud server as-is.
2. Re-platform: Also known as "lift, modify and shift", the application will be tweaked and optimized for the cloud.
3. Revise: More changes are required to the architecture and codebase while moving to cloud.
4. Rebuild: It is considered when the existing application do not meet their current business model.
5. Replace: Replacing involves migration to a third-party, pre-built application.
6. Retire: Application no longer be helpful to business are retired by simply turning them off.
7. Retain: Retain the applic? as-is and can revisit for cloud migration.

* Benefits of Cloud migration

Scalability, Reliability, Flexibility, Profitability, Performance, Productivity, Reduced cost, Security.

* Challenges:

- Moving a database is difficult.
- Interoperability becomes a problem.
- Security concern.

* Enterprise Cloud

An enterprise cloud is a unified operating environment that melds private cloud, public and distributed cloud, providing a single point of control for infra. and application in any cloud. It is ideal for large organization with diverse cloud workloads.

* Advantages

- i) Cost Saving
- ii) Security
- iii) Flexibility & Innovation
- iv) Disaster Recovery/Business Resiliency

* Types of Enterprise Cloud Architecture

There are four common models for enterprise cloud-

1. Public cloud :- A public cloud is cloud computing in which the infrastructure and services are owned and operated by a third-party provider and made available to public over internet. AWS, Microsoft Azure,
2. Private cloud :- A private cloud is a cloud computing environment in which infra. and services are owned and operated by a single organization
3. Hybrid cloud :- A hybrid environment include a mix of private and public cloud services.
4. Multi-Cloud :- A multi-cloud architecture combine services from more than one cloud provider.

* Who uses an enterprise cloud ?

- i) Healthcare
- ii) Retail
- iii) Financial Organisation
- iv) Manufacturing
- v) Federal Agencies

* Components of enterprise cloud management :

- Unified Governance model.
- Full-stack infrastructure and platform service.
- Zero-click operation and machine intelligence.
- Integrated security and governance.
- Application-centric mobility.

* Benefits of utilizing an enterprise cloud strategy:

- Focus on the end user.
- Faster response from IT.

UNIT:3

Dashrath
Nandan

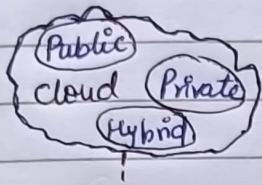
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* Cloud Data Security

Cloud data security is the practice of protecting data and other digital information assets from security threats, human error and insider threats.



[Data Security and Privacy]

- Data integrity
- Data Confidentiality
- Data Availability
- Data Privacy

[Software]

[Hardware]

* Challenges of Cloud data Security :

- i) Lack of visibility (ii) Less Control (iii) Inconsistent Coverage
- iv) Growing cybersecurity threats (v) Distributed data storage
- vi) Strict compliance requirements.

* Cloud Security Risks :

- i) Data Loss (ii) Data breaches (iii) Hijacking
- iv) DDoS attacks v) Malware Infections vi) Insider threats

* 7 Steps to Developing a Cloud Security Plan:

- 1: Review your Business Goals.
- 2: Maintain a Risk Management Program.
- 3: Create a Security Plan.
- 4: Establish Corporate-wide Support & Alignment.
- 5: Create security Policies, Procedure & Standards.
- 6: Audit and Review.
- 7: Continuously Improve.

* 5 Security Steps for Cloud Data Protection:

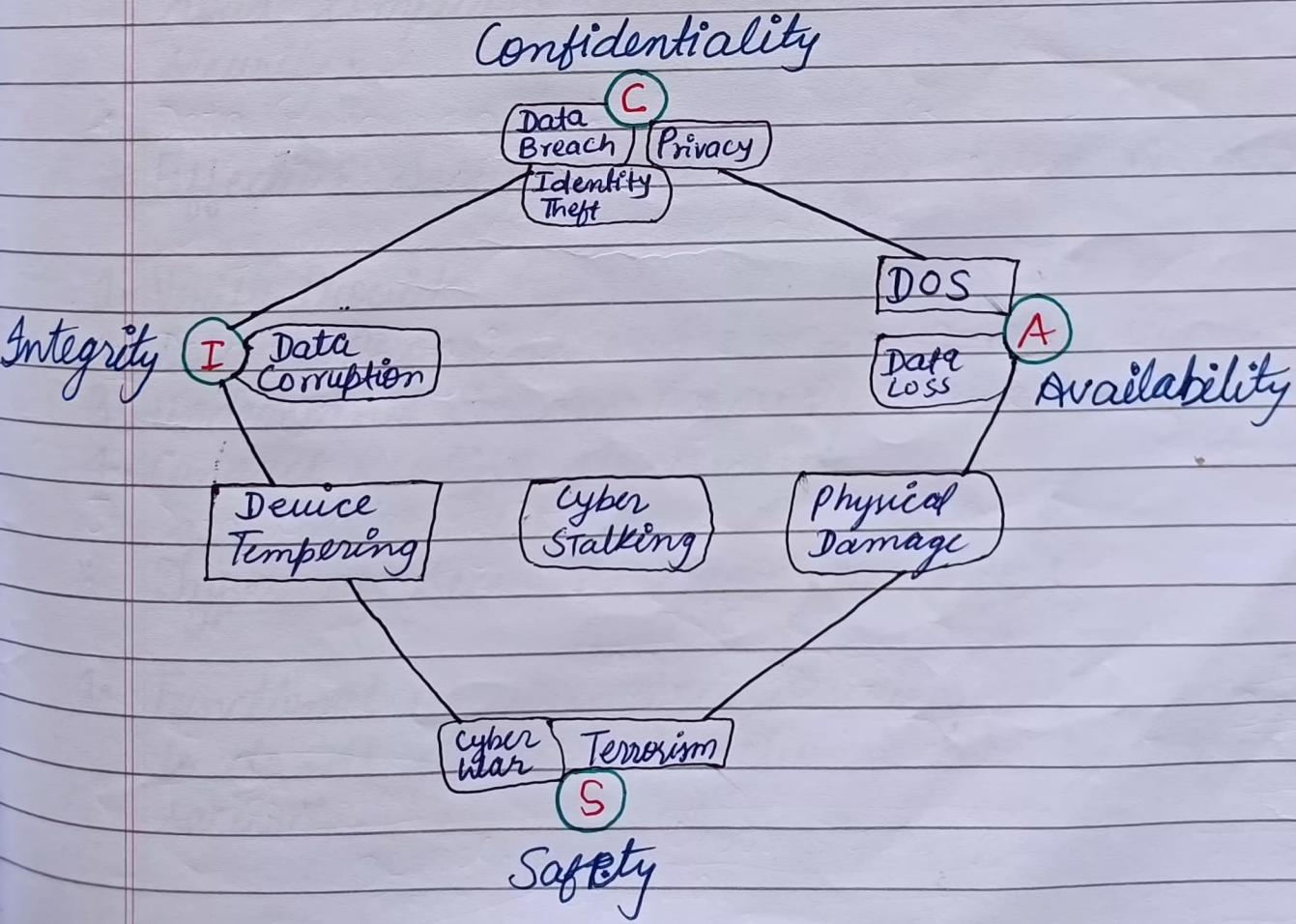
- 1: Authentication.
- 2: Encryption.
- 3: Access Control.
- 4: Secure Deletion.
- 5: Data Recovery.

- Cloud providers and customers share responsibility for cloud security. The exact breakdown of responsibilities will depend on your deployment model - IaaS, PaaS, SaaS.

* Benefits of Cloud data Security :

- Greater Visibility : It allows you to maintain visibility into inner working of your cloud, who is accessing your cloud etc
- Easy backups and recovery.
- Cloud data compliance.
- Data Encryption.
- Lower Costs.
- Advanced incident detection and response.

* Cloud Security Services : CIA Triad



Cloud data security best practice follow the same guiding principles of information security & data governance -

1. Data Confidentiality :- Data can only be accessed or modified by authorized people or processes.
2. Data Integrity :- It is the assurance that information gathered is trustworthy and reliable.
3. Data Availability :- It is guarantee of accurate access to information by authorized people.

* Secure cloud Software Requirements

Cloud computing security is the protection of an organization's sensitive data and system. Theft, leaking and destruction of data held online via cloud computing platforms are all threats to cloud security.

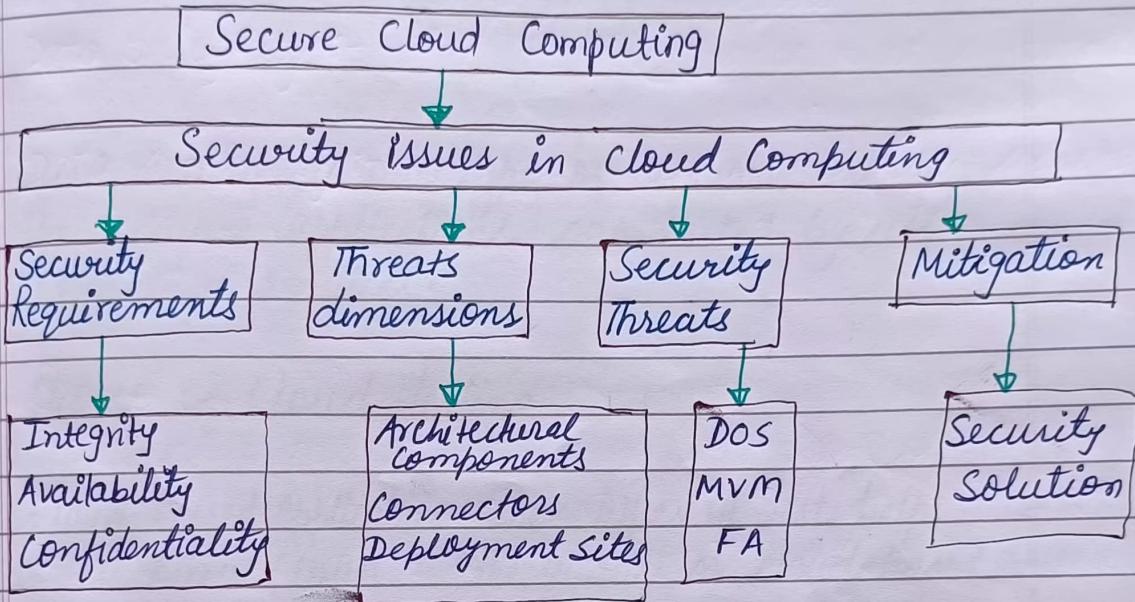
* Effective Security practices for Cloud Computing :

1. Verify Provider Compliance : Authenticate compliance.
2. Assume Proactive Role : Follow specific security procedure.
3. Understand Service Terms : Use audit records and system access logs.
4. Conduct Routine Assessments .

* Types of Security Requirements :

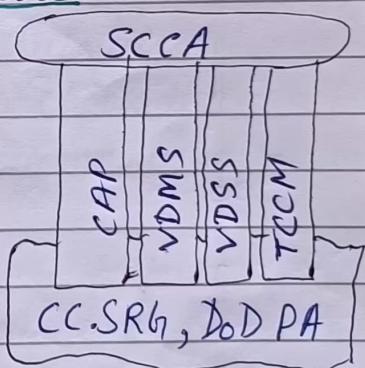
1. Functional requirements , describes what a system has to do . It describes functional behavior that enforces security .

2. Non-functional Requirements, describe the auditability and uptime.
3. Derived requirements, are inspired by the functional and non-functional requirements.



* DOD Secure Cloud Computing Architecture:

- DoD Secure Cloud Computing Architecture (SCCA) Functional Requirement Document (FRD).
- Released March 9, 2017.
- Provides implementation flexibility



* Why is it important?

- i) Identity and access management (IAM).
- ii) Proper Configuration Setting.
- iii) Firewall.
- iv) Data Encryption.

* Cloud Testing

DB Validation

Functionality Testing

Cloud Testing

Browser Comptability

- Security

- Scalability Testing

- Performance Testing

Cloud Testing, is one type of software testing in which the software applications are tested by using cloud computing services.

* Types of Cloud Testing

1. Cloud-Based Application : These types of test helps determine Test over Cloud the quality of cloud-based application concerning different types of cloud.
2. Online-Based Application : Online application supervisors/vendors Tests on a cloud perform these tests to check the functions and performance of services
3. SaaS or Cloud Oriented Testing : These tests are performed by SaaS or cloud vendors to evaluate the quality of individual service functions that are offered in SaaS or cloud programs.

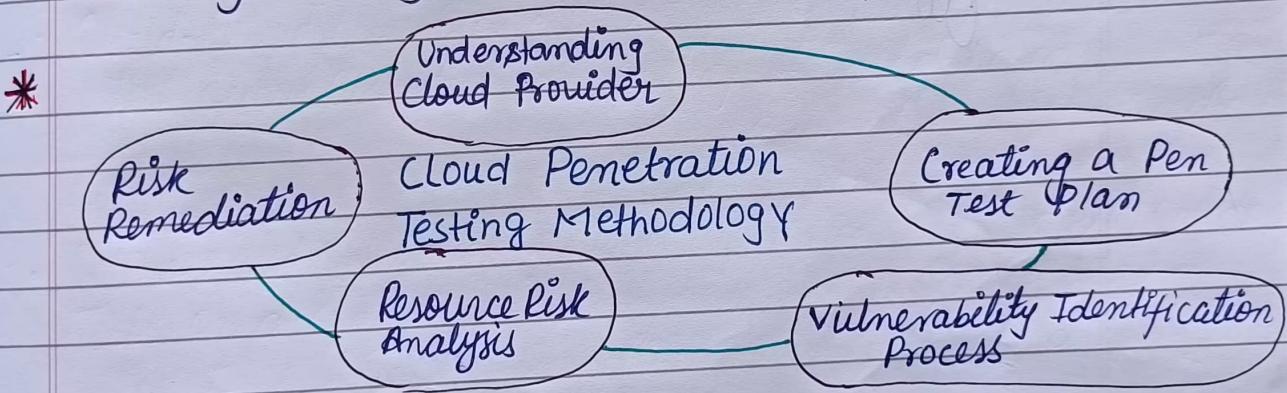
* Cloud Testing Environment

- 1) Public or Private environment : The applicn deployed inside these cloud envirn are Tested and Validated in terms of quality .
- 2) Hybrid environment :
- 3) Cloud-based environment : The applicn deployed on SaaS and PaaS models are tested and validated in terms of quality .

* Testing Performed within the Cloud

1. Functional Testing : It ensures that the business needs are being met .
 - a) System Verification Testing
 - (b) Interoperability Testing
 - c) Acceptance Testing .
2. Non-functional Testing : It is primarily specialized in web-application-based tests ensuring they meet req. needs.

Performance Testing , Stress Testing , Load Testing ,
 Latency Testing , Availability Testing , Scalability Testing
 Security Testing , Disaster Recovery Testing .



➤ Tools for Functional Testing in Cloud :

- i) AppPerfect : It supports and develops a set of testing & monitoring.
- ii) Jmeter
- iii) SOASTA Cloud Test
- iv)

➤ Tools for Security Testing in Cloud :

- i) Nessus : It is a remote security scanning tool that scans the system and raises alert if any vulnerability occurs.
- ii) Wireshark : It is an open-source packet analyzer.
- iii) Nmap : It is a network scanner used to discover host and services on a network .

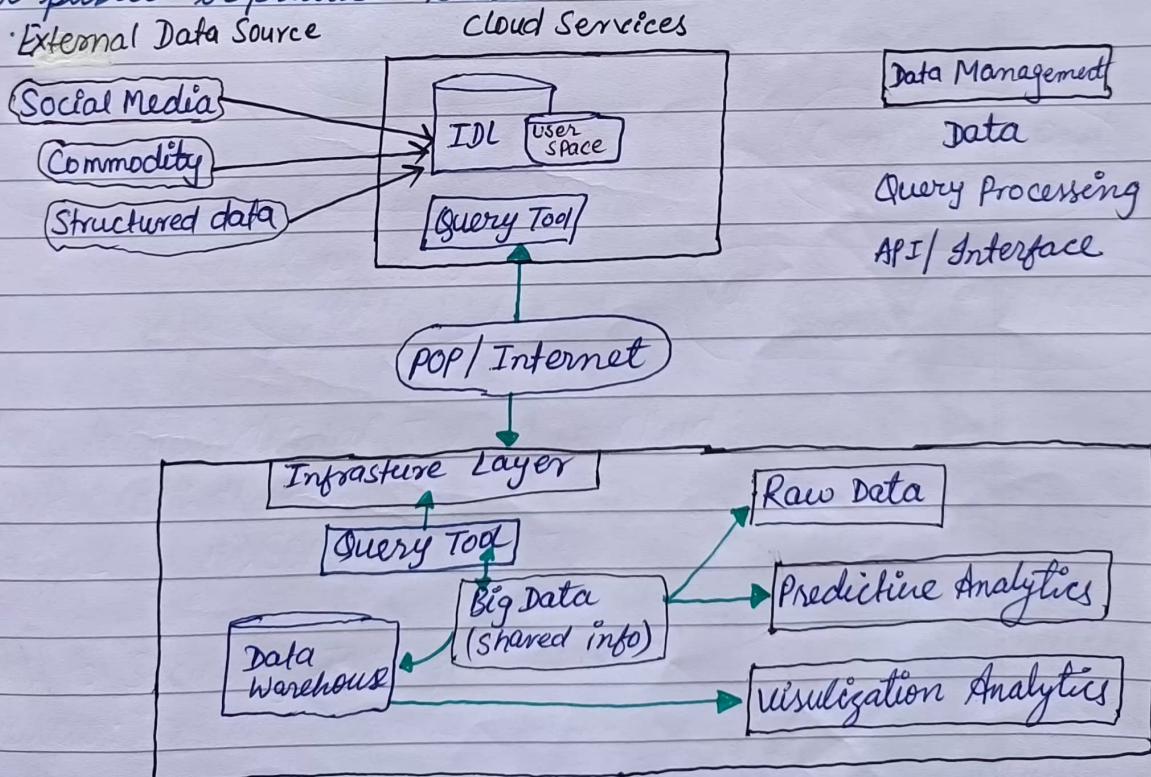
- * Challenges in Cloud Testing
 - Privacy and Data Security
 - Environment Configuration.
 - Uses of multiple-cloud models.
 - Data migration.
 - Upgradation in cloud.
 - Testing of all components.

* Benefits of Cloud Testing

- Less Expensive.
- Faster Testing
- Scalability
- Customization
- Disaster recovery.

* Cloud Analytics

Cloud analytics is a service model in which elements of the data analytics process are provided through a public or private cloud.



* Cloud Analytics Tools:

- i) Website Analytics
- ii) Sales Analytics
- iii) Financial Analytics
- iv) Performance Analytics

* Components of Cloud Analytics :

- 1.) Data Source
- 2.) Data Models
- 3.) Processing Application
- 4.) Computing Power
- 5.) Analytics Models
- 6.) Data Sharing and Storage.

* Top Cloud Analytics Platforms :

Board , Tableau , IBM Cognos , Qlik Sense Enterprise

* Advantages :

- i) Increased Collaboration , Scalability .
- ii) Improved Accessibility .
- iii) Enhanced Security .
- iv) Flexible Performance .

* Conventional Testing

- Software testing is conducted using on-premises infra.

- Testing resources, such as H/w, s/w are installed and maintained within organization's premises.

- It is less scalable or limited.
- It requires significant upfront investment.

- Testing is performed on fixed configuration and environment.

Cloud Testing

- It provides on-demand access to scalable testing environment.

- Testing resources are hosted and managed by cloud service providers.

- It offers greater scalability.
- It reduces upfront cost and pay-as-you-go basis.

- It enables testing across broader range of configuration and environment.

* Map Reduce and GFS

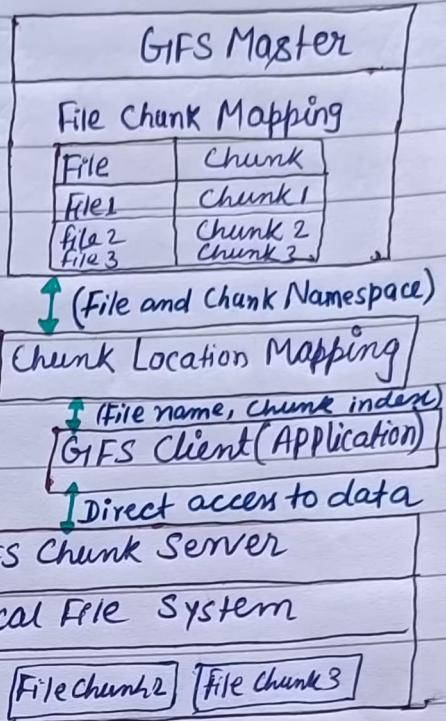
* GFS (Google File System)

It is a Scalable distributed file System (DFS) for large distributed data intensive application.

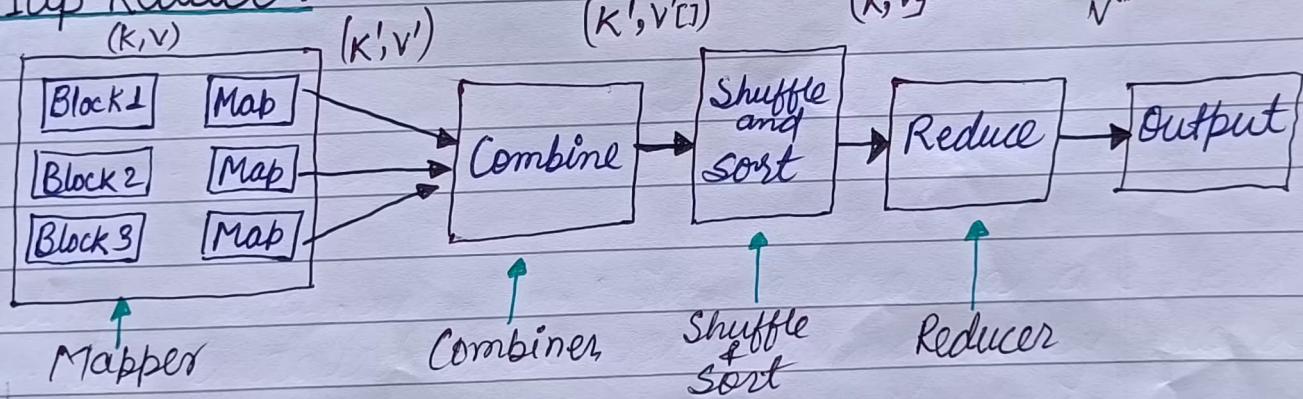
The GFS node consists of a single master and several chunk servers.

Component -

GFS client, GFS Master Server
, GFS Chunk Servers.



* Map Reduce:



- The Map Reduce is a processing technique and a program model for distributed computing of big sets of data.
- It contains two important tasks, namely **Map** and **Reduce**. **Map** takes a set of data and converts it into another set of data, where individual elements are broken down into tuples (key/value pairs).
- **Reduce** tasks, takes output from a map as an input and combines into smaller set of tuples.

● Elaborate the diagram and their component according to weightage of question.

* Big Data

Big data contains large amount of data that is not being processed by traditional data storage or processing unit

Characteristics :- (8V's)

- | | |
|--|--------------------------------|
| 1. Volume : Huge amount of data | 2) Value : Extract useful data |
| 3. Variety : Diff. formats of data from various sources. | |
| 4. Velocity : High speed of accumulation of data | |
| 5. Veracity : Inconsistencies and uncertainty in data. | |
| 6. Visualization | 7) Virality |
| | 8) Viscosity |

* Hadoop :

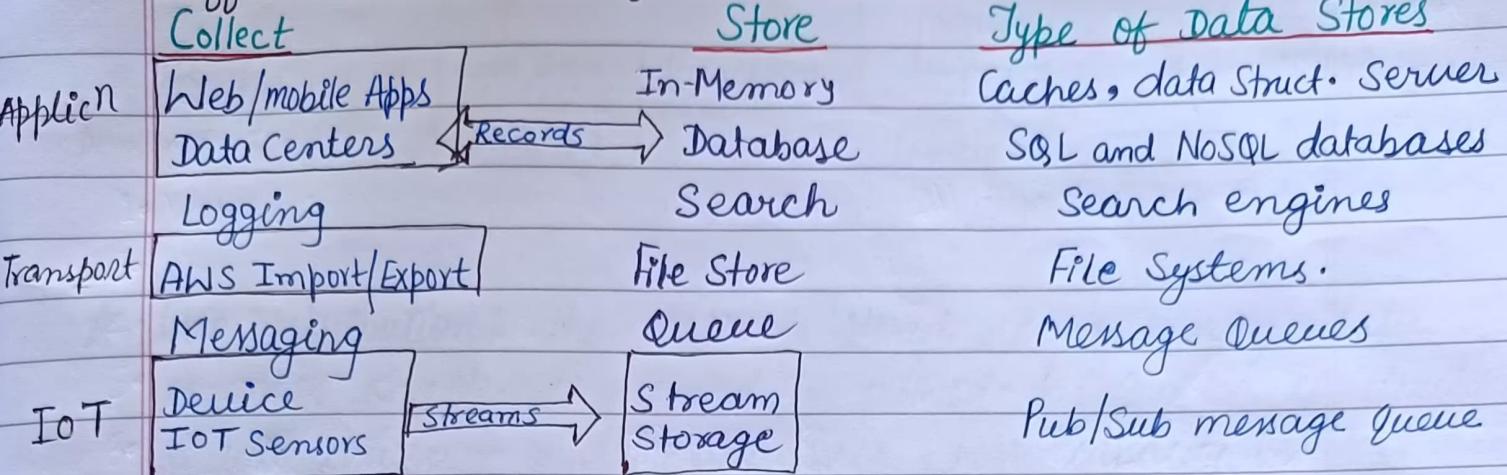
Hadoop is an open-source software framework that is used for storing and processing large amount of data in a distributed computing environment. It is designed to handle big data.

Others , Hadoop Common (for Data Processing)	Map Reduce (For Data Processing)
YARN (Resource Management For clusters)	
HDFS (A Reliable & Redundant Storage)	

Hadoop Architecture mainly consist of 4 components -

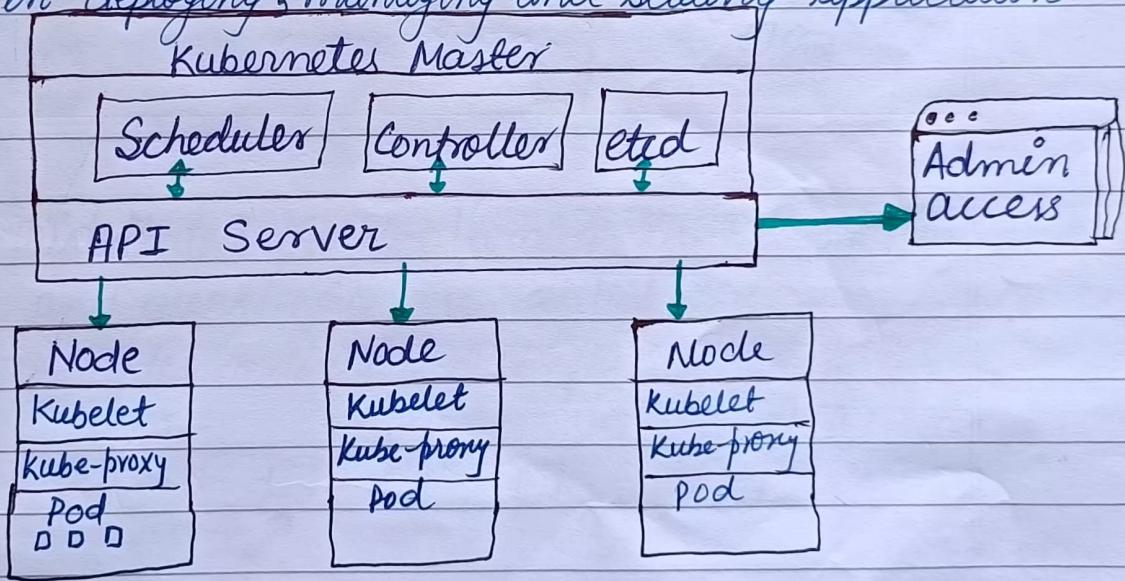
- i.) Map Reduce
- ii) HDFS (Hadoop Distributed File System).
- iii) YARN (Yet Another Resource Negotiator).
- iv) Common Utilities or Hadoop Common.

* Different modules of Data stores



* Micro Services : Kubernetes

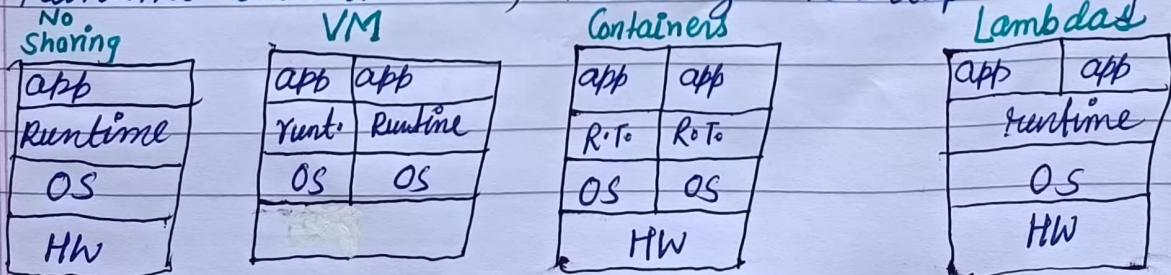
Kubernetes is an open source container orchestration platform that automates many of the manual processes involved in deploying, managing and scaling application

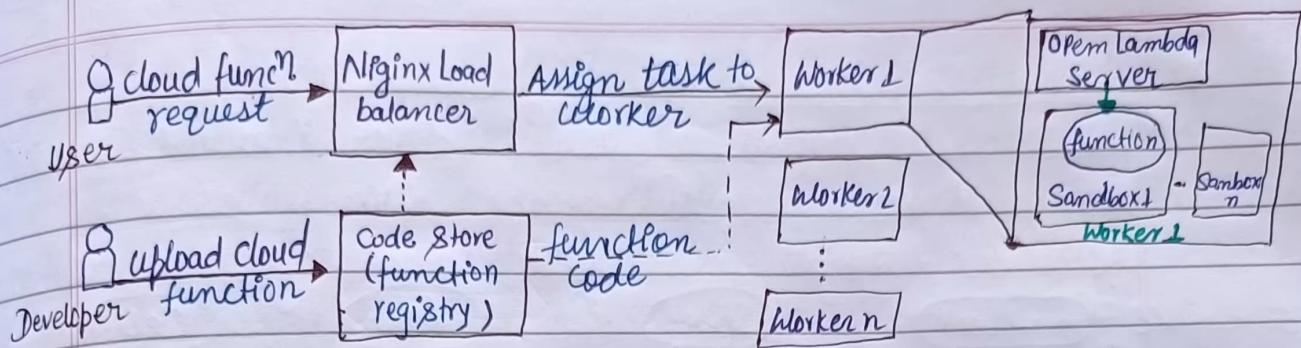


* Serverless Computations with Open Lambda

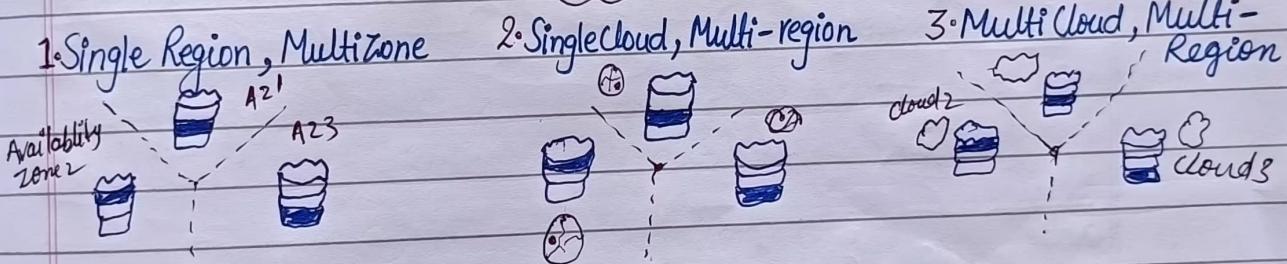
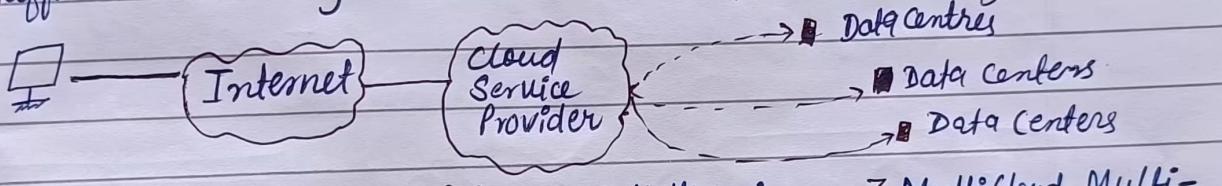
- No share Management for developers, Functions share the runtime environment, minimize startup latency.

Evolution of Sharing :

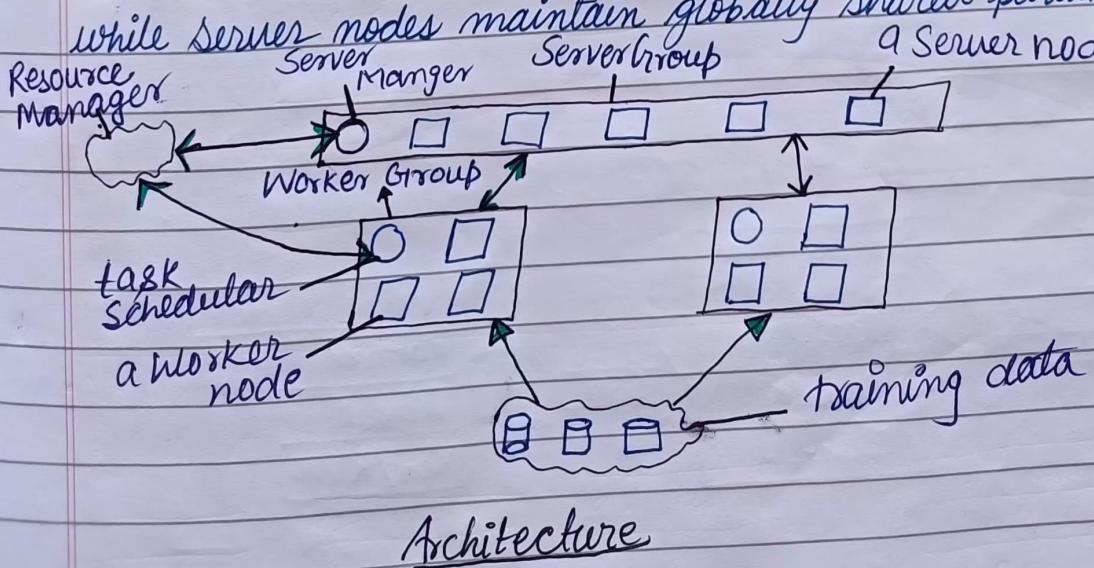




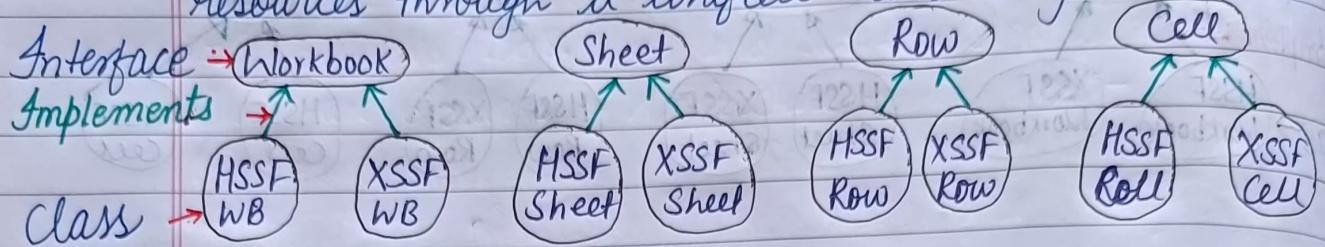
★ **Geo Distribution:** The data is stored across many data centers, scattered around the world. 4 things for construction of data centers - Suitable phy. Space, high-capacity Internet Conn., affordable electricity & Resource and law, policies and Regulation.



★ **Scaling Distributed Machine Learning with Parameter Servers**
Both data and workloads are distributed over worker nodes, while server nodes maintain globally shared parameters.

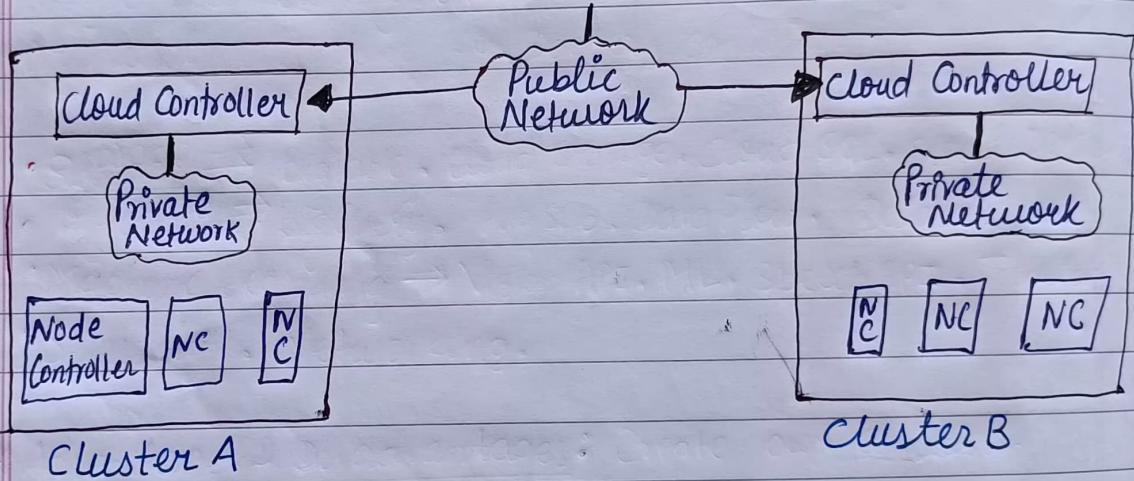


* Library from Apache: Apache Libcloud is a Python library which hides differences between different cloud provider APIs and allow you to manage different cloud resources through a unified and easy to use API.



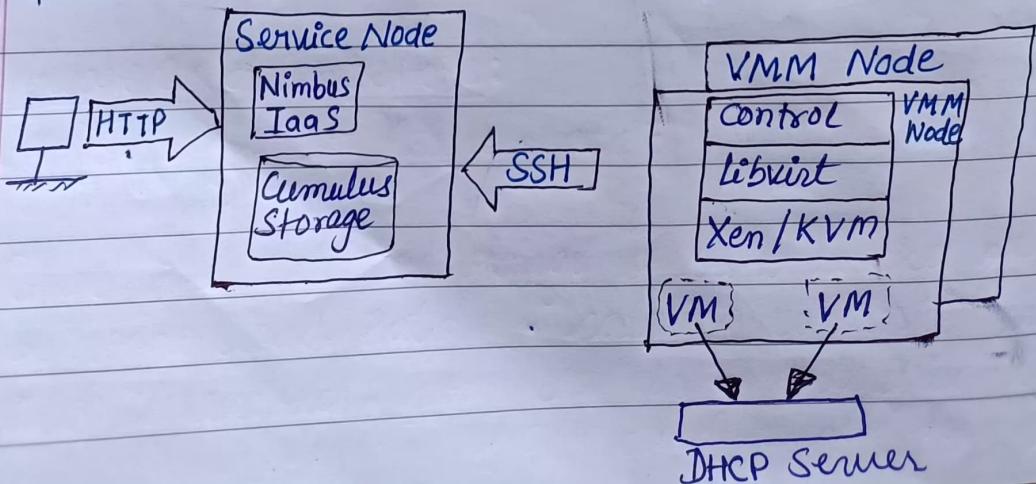
* Eucalyptus: Eucalyptus is a Linux-based open-source software architecture for cloud computing and also a storage platforms that implements IaaS.

CLC and Walrus

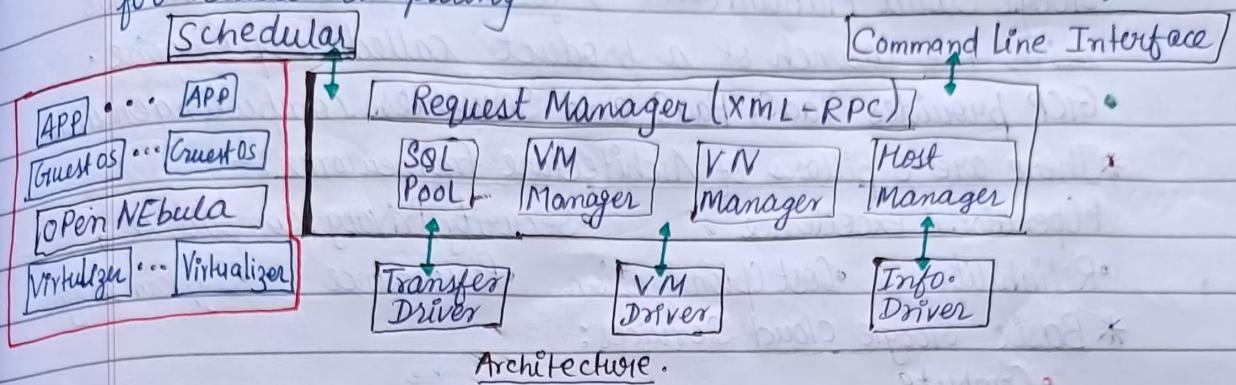


* Nimbus: It is a general purpose cloud computing system specially designed for computations with short tasks.

- Open source, extensible IaaS implementation.

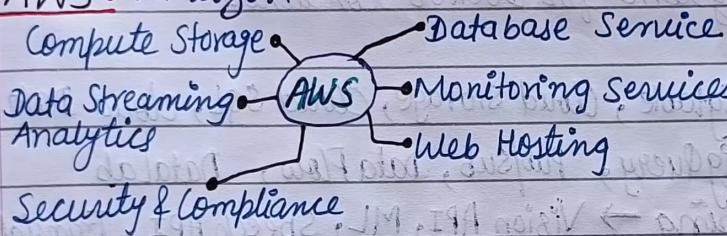


Open Nebula: The open source Virtual Machine manager for cluster Computing.

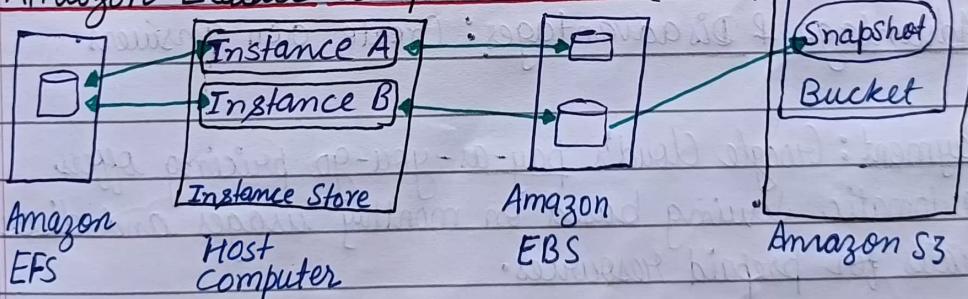


Open Nebula helps integration with various Storage as well as network infrastructure config. & hypervisor technologies.

* AWS: Amazon Web Services



* Amazon Elastic Compute Cloud (EC2)



► EC2 = Elastic Compute Cloud = IaaS

► It consists of the capability of:

- Renting virtual machine (EC2)
- Storing data on virtual drives (EBS).
- Distributing load across machines (ELB).
- Scaling the services using auto-scaling app (ASG).

Most probably direct questions on case studies will not come. But if question is asked try to elaborate things that you know.

classmate

Page

Case Studies

Draw diagrams, related to topic or any words or keywords. (lenient checking will be done.)

* Google Cloud:

- Google Cloud Platform (GCP) first came online in 2008 with the launch of a product called App Engine.
- GCP provides IaaS, PaaS and Serverless computing environ.

* There are 6 pillars of Architecture frameworks :-

- Operational Excellence
- Reliability
- Cost Optimization
- Security, Privacy, Compliance,
- Performance
- System Design

* Basic Google cloud Services:

• Compute

- App Engine
- Compute Engine
- Container Engine
- Google APP Engine offers PaaS.
- Google Compute Engine offers IaaS (VM), etc.
- Google Kubernetes Engine (GKE), which is management and orchestration system for Docker container.

- Storage → Bigtable, Cloud Storage, Cloud SQL, Cloud Datastore
- Big data → BigQuery, Pub/Sub, Data Flow, DataLab
- Machine Learning → Vision API, ML, Speech API, Translate API.
- Security, Networking,

* Advantage & Disadvantages: Create own answers.

- Payment: Google Cloud's pay-as-you-go pricing offers automatic saving based on monthly usages and discounted rates for prepaid resources.

* Google Cloud Competitors:

AWS, Microsoft Azure, etc.

- There are extensive range of cloud services offered by Google Cloud Platform, catering to various use cases and industries, from startups to enterprise-level.
(Draw Diagram of any cloud related topics)

* EMC VMWare :

- EMC Corporation is the world's leading provider of data storage systems and storage hardware solutions providing Information Technology as a Service. EMC implements VMWare.
- In 1998, VMWare was founded. VMWare provides cloud computing and virtualization technology.
[Virtualization, types, diagrams, uses, etc]
[Discuss, (Unit 2, Notes)]

➤ VMWare infrastructure delivers the resources your infra. needs and enables you to : Reduce energy costs by 80%, power down servers without affecting applications or users.

VMware Case Study:-

- Initially billing back only 54% of IT costs using primarily an allocation approach, EMC sought greater transparency in aligning IT with business needs. Engaging with EMC Consulting, they refined their approach, resulting in billing back 89% of IT costs. This focus on financial transparency increased IT investment in growth and innovation from 23% to 42%, spending on enterprise-wide rising from 42% to 76%, highlighting the success of their transformation journey. The VMWare solution replaced the previous complex model with simpler logic, streamlining data processes, enhancing business intelligence, empowering more effective collaboration with business partners.

* Microsoft Azure :

It was officially launched as Windows Azure in Feb, 2010 and later renamed to Microsoft Azure on 25 Mar, 2014.

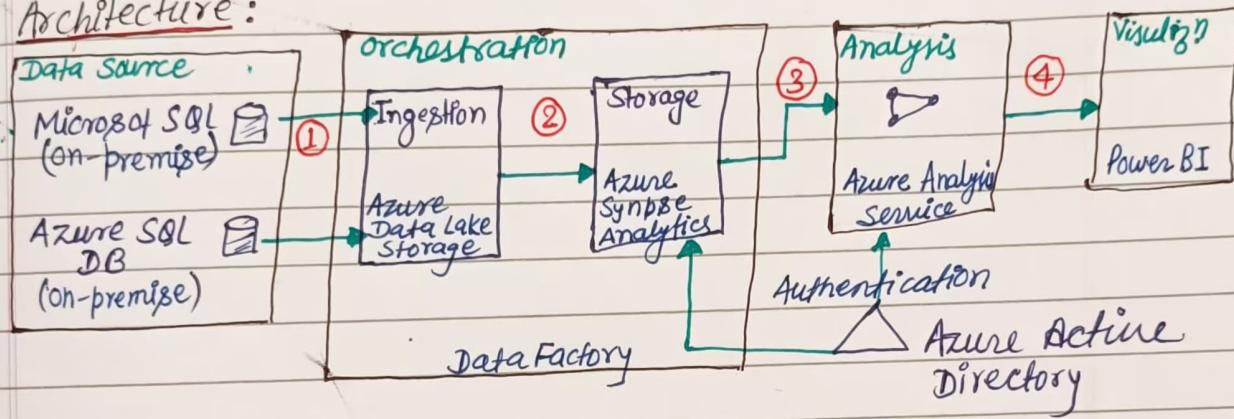
- Azure is a public cloud computing platform - with solutions including IaaS, PaaS and SaaS that can be used for services as Analytics, Virtual computing, Storage, Networking, etc.

Azure also provides Data Recovery and Backup. It is also commonly used as a platform for hosting database in the cloud.

* It uses Pay-as-you-go model.

Key Characteristics :- Accessibility, Scalability, Cost-effectiveness, Security, Reliability.

Architecture:



* AWS (Amazon Web Service)

The genesis of AWS came in early 2000s. In July 2002, Amazon.com Web Services launched its first web services, opening up platform to all developers. On 14 Mar, 2006, AWS launched Amazon S3 cloud storage followed by EC2 in August 2006.

• AWS is a cloud computing platform that includes IaaS, PaaS offerings. AWS services offer scalable solutions for compute, storage, database, analytics and more.

• Features: Flexibility, Cost-effective, Scalable and elastic, Secure, Experienced.

Component of Global Infrastructure:

- Availability Zone: It is a facility somewhere in a country or city. It has data centres, multiple servers, switches, firewalls.
- Region: Each region consists of 2 or more Availability Zones.
- Edge location: are the endpoints for AWS used for caching content.
- Regional Edge Cache, lies between Cloud Front Origin Server and edge location.