

Module 2

INTRODUCTION TO CLOUD COMPUTING - System Models for Distributed & cloud computing - S/E Environment for distributed system & clouds - Cloud Computing and Service models - Public - Private - Hybrid model clouds - IaaS - PaaS - SaaS - Different Service Providers.

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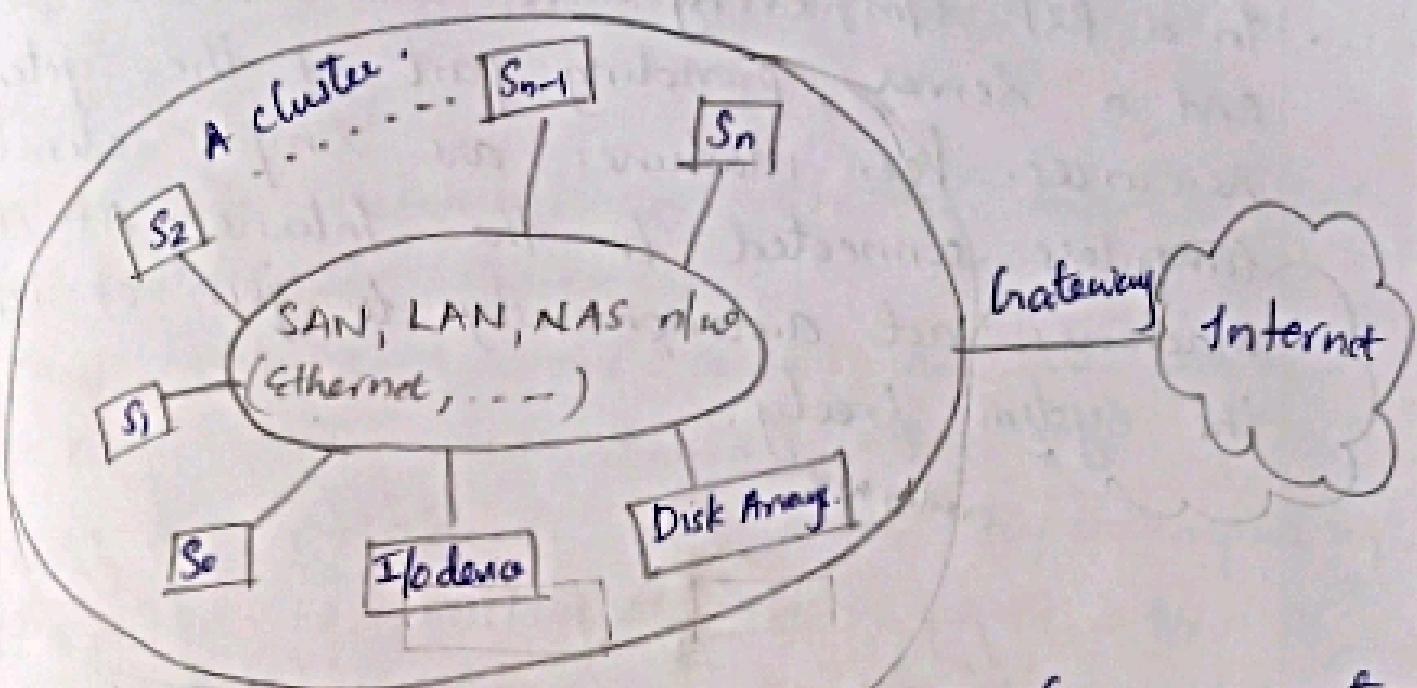
SYSTEM MODELS FOR DISTRIBUTED AND CLOUD COMPUTING.

- Distributed and Cloud computing systems are built over a large no. of autonomous computer nodes.
- These node machines are interconnected by SAN's, LAN, or WAN in a hierarchical manner.
- A WAN can connect many local clusters to form a very large cluster of clusters.

Classification of Distributed Computing Systems

- 1) cluster computing
- 2) Peer - to - peer networks .
- 3) Grid computing
- 4) Cloud computing .

cluster computing



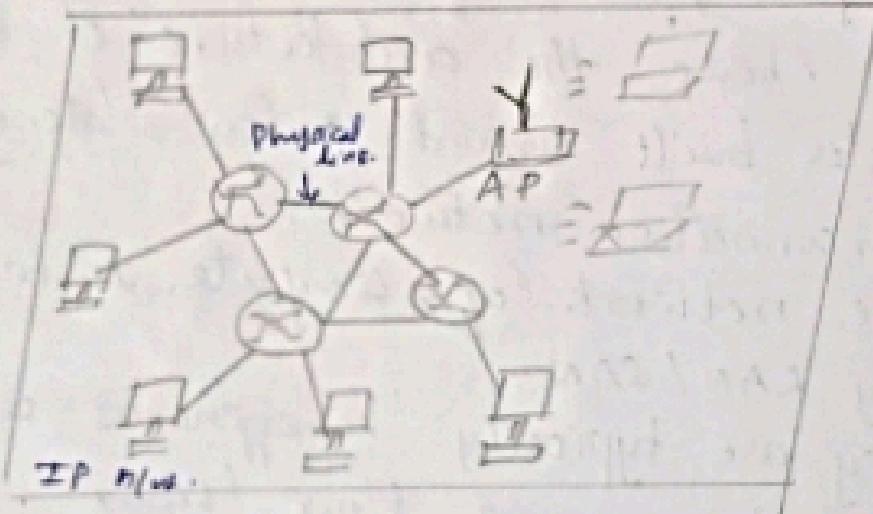
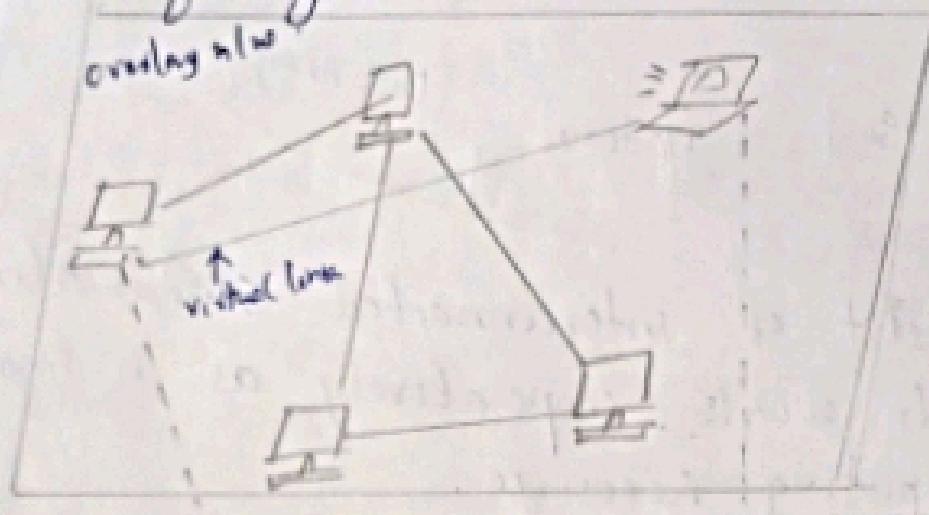
- consist of interconnected stand-alone computers which work cooperatively as a single integrated computing resource.
- Fig shows the architecture of a typical server cluster built around a low latency, high bandwidth interconnection network.
- The network of compute nodes are connected by LAN/SAN.
- They are typically homogeneous with distributed control running Unix/Linux.
- They are suited to HPC.

Peer - to - Peer Networks

- consists of interconnected stand-alone computers which work cooperatively as a single integrated computing resource.
- The P2P architecture offers a distributed model of n/w s/m.

P2P Systems

- In a P2P system, every node acts as both a client and a server, providing part of the system resources. Peer machines are simply client computers connected to the Internet. All client machines act autonomously to join or leave the system freely.

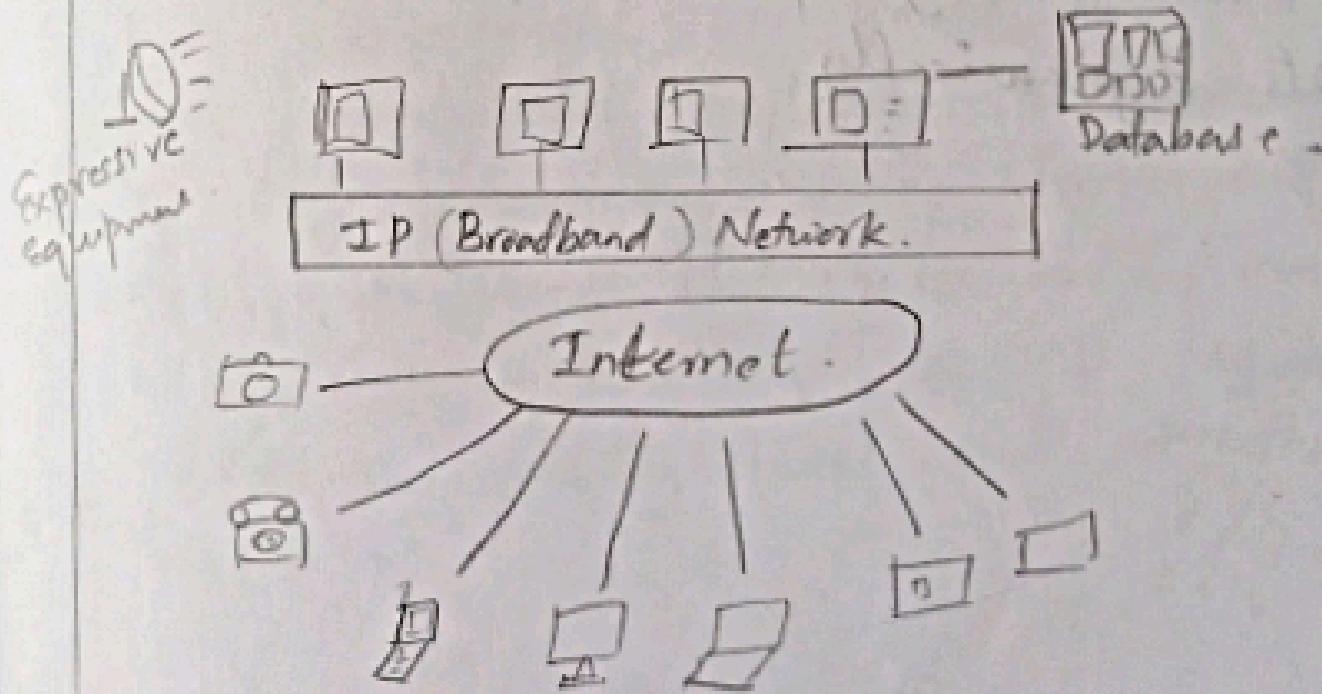


- Every node acts as both client & server.
- Peer act autonomously to join or leave a n/w.
- No central co-ordination or central database is needed.
- No Peer - machine has a global view of the entire P2P sys.
- The System is self-organizing with distributed control.

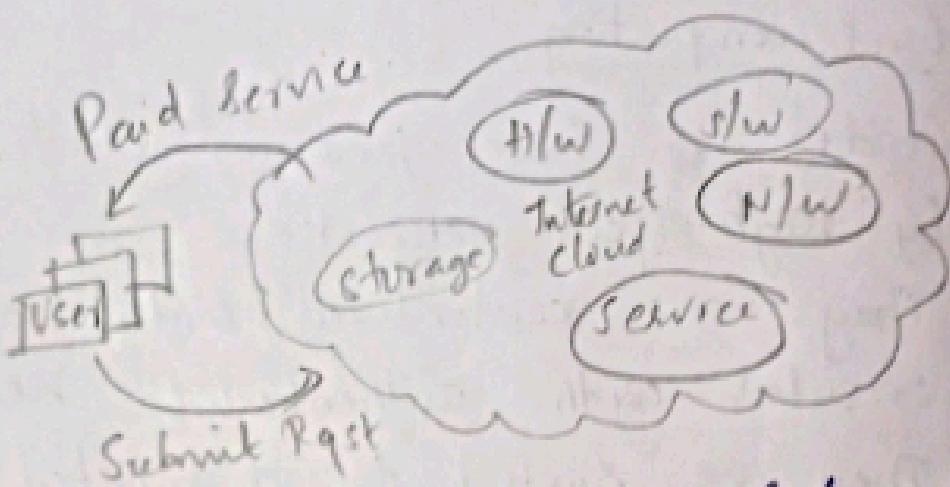
- Unlike a cluster / grid, a P2P n/w does not use dedicated interconnection n/w.

Grid Computing

- Grids are heterogeneous clusters interconnected by high-speed networks.
- * They have centralized control and are server-oriented with authenticated security.
- * They are suited to distributed supercomputing. The grid is constructed across LANs, WANs or Internet backbones at regional, national or global scale.
- * The computers used in a grid include servers, clusters, and super computers.
- * PCs, laptops and mobile devices can be used to access a grid system.



Cloud Computing.
A cloud is a pool of virtualized computer resources.



- workloads can be deployed and scaled out quickly through rapid provisioning of VMs.
- Virtualization of server resources has enabled cost effectiveness and allowed cloud systems to leverage low costs to benefit both users & providers
- It applies a virtual platform with resources on demand by provisioning h/w, s/w & data sets dynamically.

Software Environments for Distributed Systems and Clouds.

Service - Oriented Architecture.

In grids / web services, Java & CORBA, an entity is, respectively, a service, a Java object and a CORBA distributed object in a variety of languages. These architectures build on the traditional seven ~~open~~ OSI layers that provide the base networking abstractions. On top of ~~base~~ this we have a base software environment which would be .NET or Apache Axis for Web services, the java virtual machine for Java, broker in/w for CORBA. On top of this base environment one would build a higher level environment reflecting the special features of D-C environment. This starts with entity interfaces and inter-entity communication which rebuild the top 4 OSI layers but ~~at~~ at the entity level and not the bit level.

- * It is a style of SW design where services are provided to other components by application components, through a communication protocol over a network.
- * A SOA service is a discrete unit of function that can be accessed remotely and called upon and updated independently, such as retrieving a credit card statement online.
- * SOA is also intended to be independent of vendors, products & technologies.

4 properties:

- 1) It logically represents a business activity with a specified outcome.
- 2) It is self-contained. (self-processed)
- 3) It is a black box for its consumers, meaning consumer does not have to be aware of the service's inner working.
- 4) It may consist of other underlying services.

Major roles

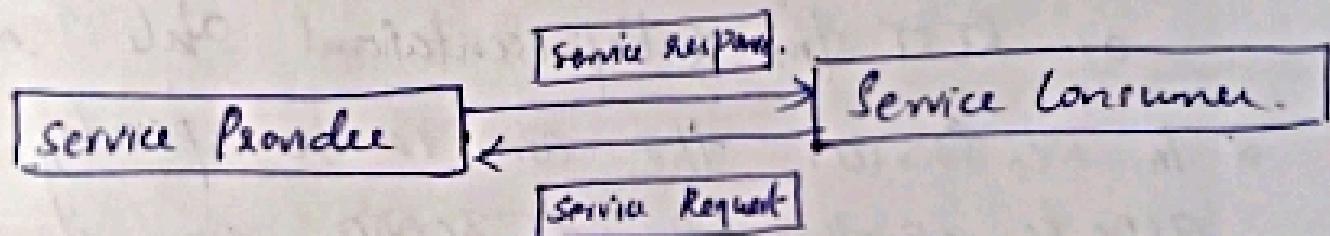
- 1) Service Provider.
- 2) Service Consumer.

Service Provider

It is the maintainer of the service and organization that makes available one or more services for others to use. To advertise services the provider can publish them in a registry together with a service contract that specifies the nature of the service, how to use it, the requirements for the service, and the fees charged.

Service Consumer

The Service consumer can locate the service metadata in the registry and develop the required client components to bind and use the service.



Layered Architecture for Web Services & Grids

- * The entity iff correspond to WSDL (Web Services Description language), Java method, & CORBA IDL (Interface Definition Language) specifications in these examples distributed systems.
- * These iff are linked with customized, high-level communication s/m : SOAP, RMI & IIOP.
- * These commⁿ s/m supports RPC, fault recovery and specialized routing.

* Entity communication is supported by higher level services for services, metadata, and the management of entities.

Eg: JNDI, CORBA trading service, UDDI, LDAP & ebXML.

- * Services have a common service : a shared memory.
- * This enables effective exchange of information.
- * higher performance & more throughput.

Web Services & Tools.

- * Loose coupling & support heterogeneous implementation
- * Two choices of service architecture: Web services or RESTful (Representational State Transfer).
- * In Web Services, the aim is to specify all aspects of the offered service and its environment (SOAP).
- * In REST approach, simplicity is stressed upon and difficult problems are delegated to the apps. REST architecture are more useful in rapid technology environment.

The Evolution of SOA

Raw Data → Data → Information →
knowledge → Wisdom → Decisions.

- * SOA applies to building grids, clouds, their combination.
- * The data collection is done through sensors like ZigBee device, Bluetooth device, Wi-Fi access point, a PC, a mobile phone & others.
- * All these devices interact among each other or with grids, clouds & databases at distant places.

Distributed OS

It is a SW over a collection of independent, networked, communicating and physically separate computational nodes.

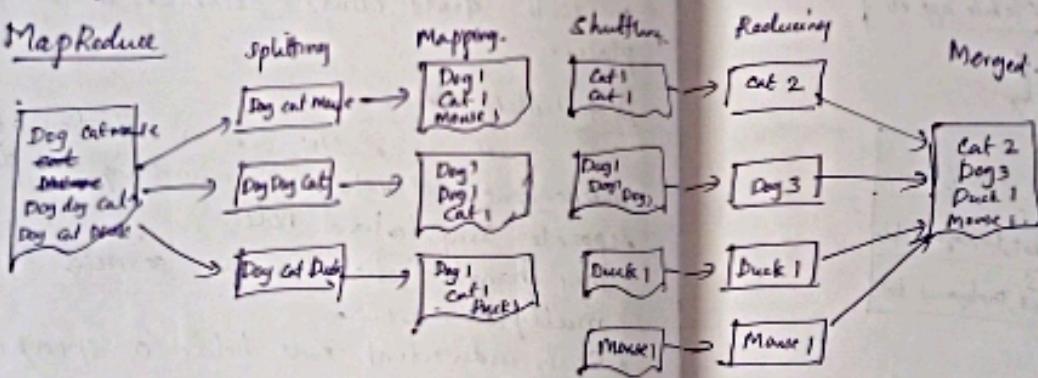
- * They handle jobs which are serviced by multiple CPUs.
- * Each individual node holds a specific SW subset of global aggregate OS.
- * Each subset is a composite of two distinct service provisioners:
 - 1) ubiquitous minimal kernel or micro kernel that directly control that's node's H/W.
 - 2) higher level collections of SW management components that coordinates nodes' individual activities.

Parallel & Distributed Programming Model

i) Message Passing Interface (MPI):

- To develop parallel & concurrent programs, run on a distributed sys., we use MPI
- Library of sub programs that can be called from C or FORTRAN to write parallel programs running on a D.S.
- Synchronous or asynchronous, point-to-point
- High performance, scalability & portability.

ii) MapReduce



* applied mainly in web-scale search & cloud computing applications.

- Map function to generate a set of intermediate key/value pairs.
- Reduce - merge all intermediate values with same intermediate key.

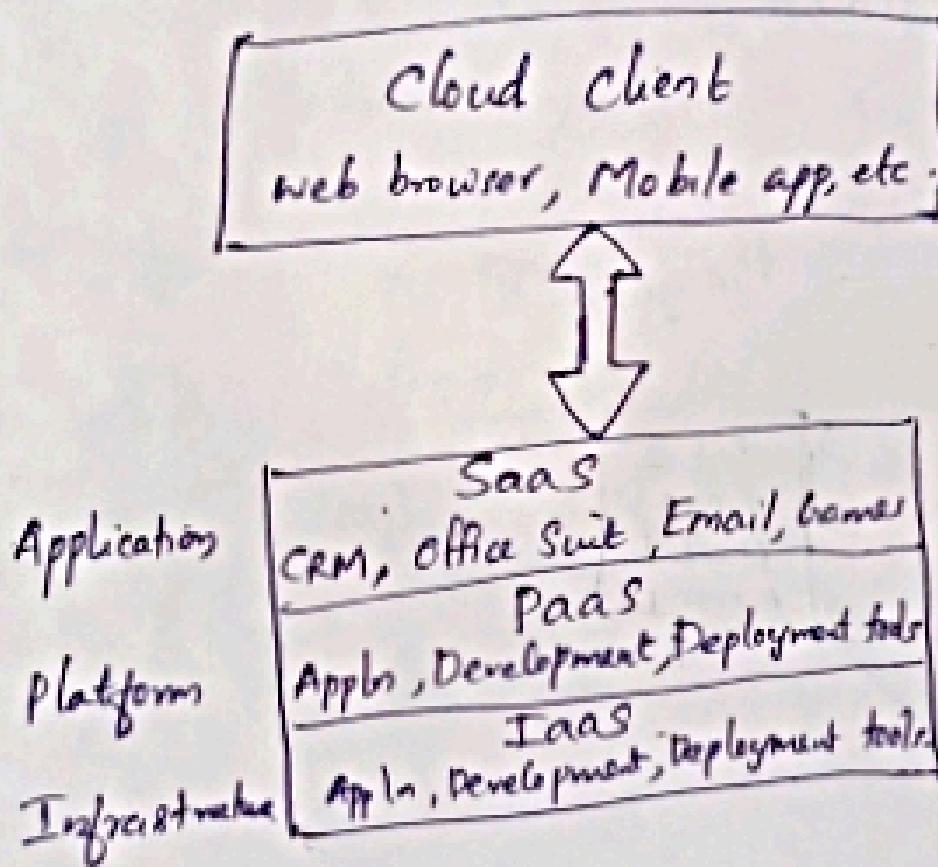
iii) Hadoop library:

- S/w platform that was originally developed by a Yahoo! group.
- The package enables users to write and run applications over vast amounts of distributed data.
- Scalability, economical, efficient, reliable.

CLOUD COMPUTING & SERVICE MODELS

Cloud Computing is based on service model.
The service models are categorized into three basic models :

- 1) Software - as - a - Service (SaaS)
- 2) Platform - as - a - Service (PaaS)
- 3) Infrastructure - as - a - Service (IaaS)

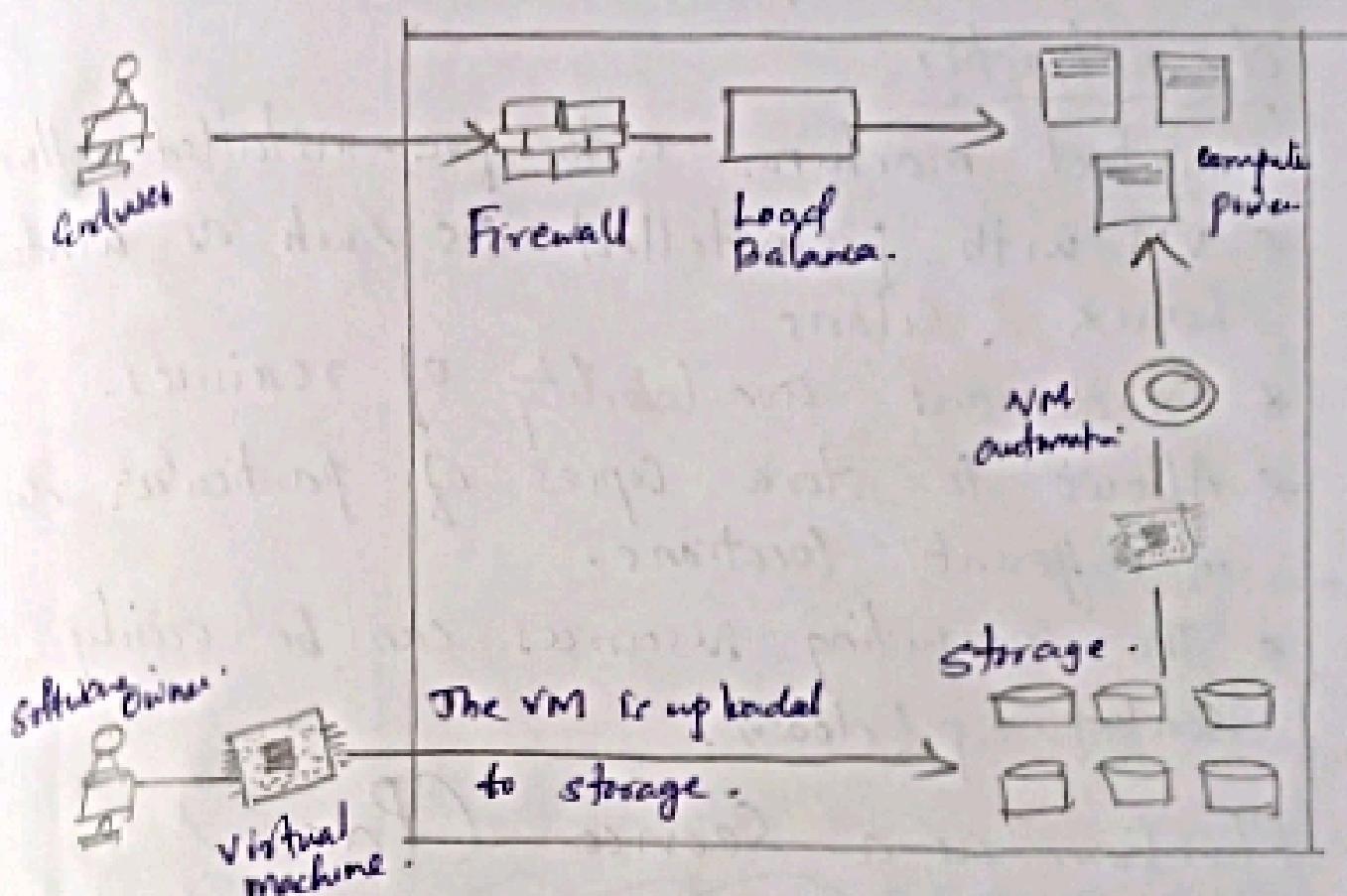


Infrastructure as a Service (IaaS)

IaaS provides access to fundamental resources such as physical machines, virtual machines, virtual storage etc. It also offers

- * Virtual machine disk storage.
- * VLANs
- * Load balancers.
- * IP addresses.
- * Software bundles.

All of the above resources are made available to end user via server virtualization. Moreover, these resources are accessed by the customers as if they own them.



Benefits:

It allows the cloud provider to freely locate the infrastructure over the internet in cost-effective manner. Some of the key benefits are

- * Full control of the computing resources through Administrative Access to VMs.
- * Flexible & efficient renting of computer Hardware.
- * Portability, Interoperability with Legacy applications.

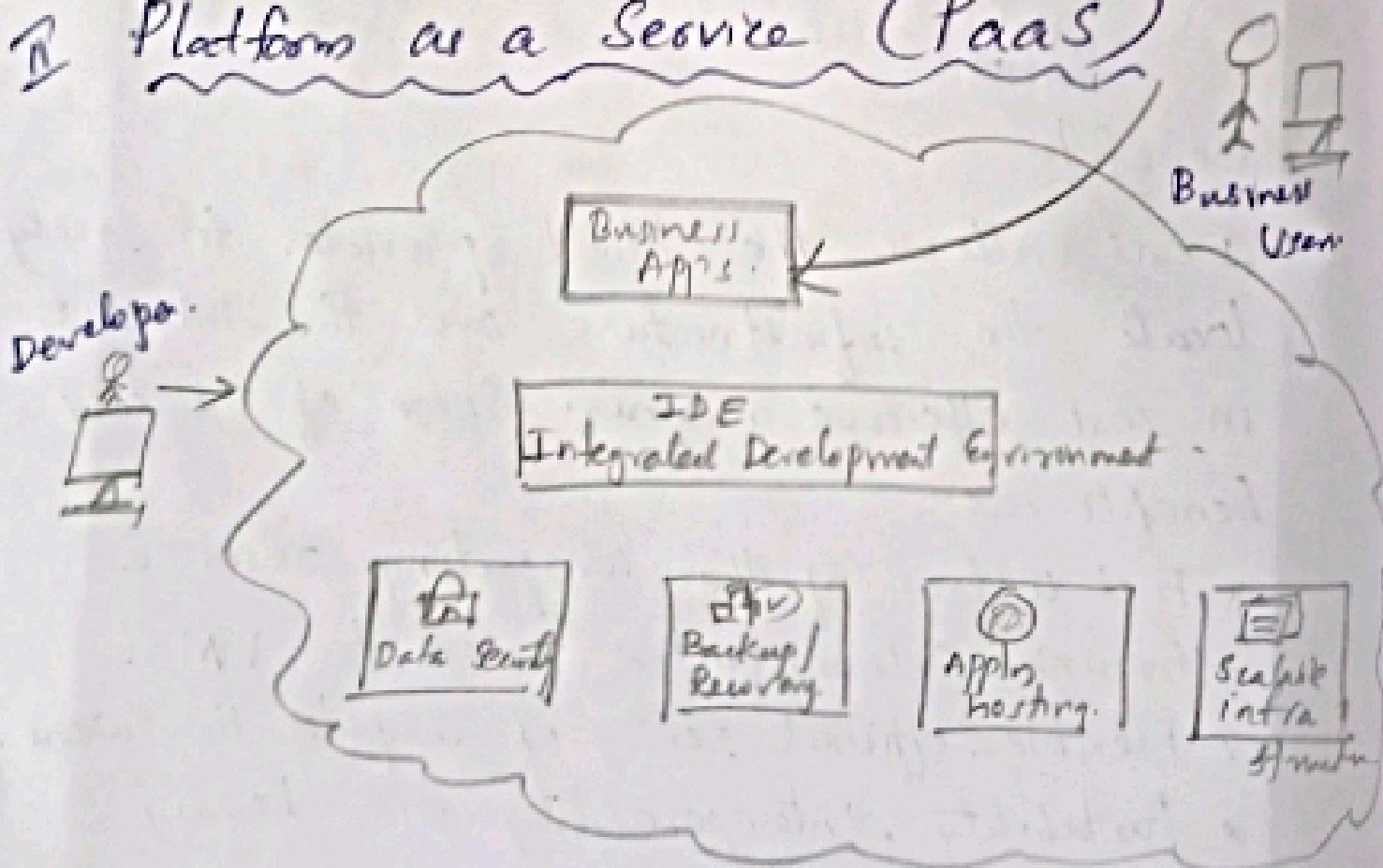
Issues :

- * Compatibility with legacy security vulnerabilities.
- * Virtual Machine sprawl.
- * Robustness of VM-level Isolation.
- * Data Erase practices.

Characteristics

- * Virtual machines with pre-installed software.
- * VM with preinstalled OS such as windows, linux & Solaris.
- * On-demand availability of resources.
- * Allows to store copies of particular data in different locations.
- * The computing resources can be easily scaled up/down.

3 Platform as a Service (PaaS)



PaaS offers the run time environment for applications. It also offers development & deployment tools, required to develop applications. PaaS has a feature of point-and-click tools that enables non-developers to create web applications.

Benefits:

- * Lower administrative overhead.
- * Lower total cost of ownership.
- * Scalable solutions.
- * More current system software.

Issues

Like SaaS, PaaS also place significant burdens on consumers' browsers to maintain reliable and secure connections to the provider's systems. Therefore, PaaS shares many of the issues of SaaS. However, there are some specific issues associated with PaaS as listed below:

- * Lack of portability b/w PaaS clouds.
- * Event Based Processor scheduling.
- * Security Engineering of PaaS applications.

Advantages

- PaaS is easier to develop. Developer can concentrate on the development and innovation without worrying about the infrastructure.
- In PaaS, developer only requires a PC and an internet connection to start building applications.

III Software as a Service (SaaS)

It allows to provide sw applications as a service to the end user. It refers to a software that is deployed on a hosted service and is accessible via internet. There are several SaaS applications.

- * Billing & invoicing system.

- * Customer Relationship Management (CRM) apps.

- * Human Resource (HR) solutions.

Characteristics

- * SaaS makes the software available over the internet.

- * The software are maintained by the vendor rather than where they are running.

- * The licence to the software may be subscription based or usage based. And it is billed on recurring basis.

- * SaaS applications are cost effective since they do not require any maintenance at end user side.

- * They are available on demand.

- * They can be scaled up or down on demand.

- * They are automatically upgraded and updated.

- * All users are running same version of the software.

- * SaaS offers share data model.

Benefits

- * scalability , efficiency , performance . . .
- * modest software tools.
- * efficient use of software licenses.
- * centralized Management & Data .
- * Platform responsibilities managed by provider
- * Multitenant solutions.

Issues

- * Browser based risks .
- * Network dependence
- * Lack of portability b/w SaaS clouds.

CLOUD DEPLOYMENT MODELS

- 1) Public cloud model .
- 2) Private cloud model .
- 3) Hybrid cloud model .

Public Cloud Model

It allows systems and services to be easily accessible to general public . Eg: Google, Amazon, Microsoft offers cloud services via internet .

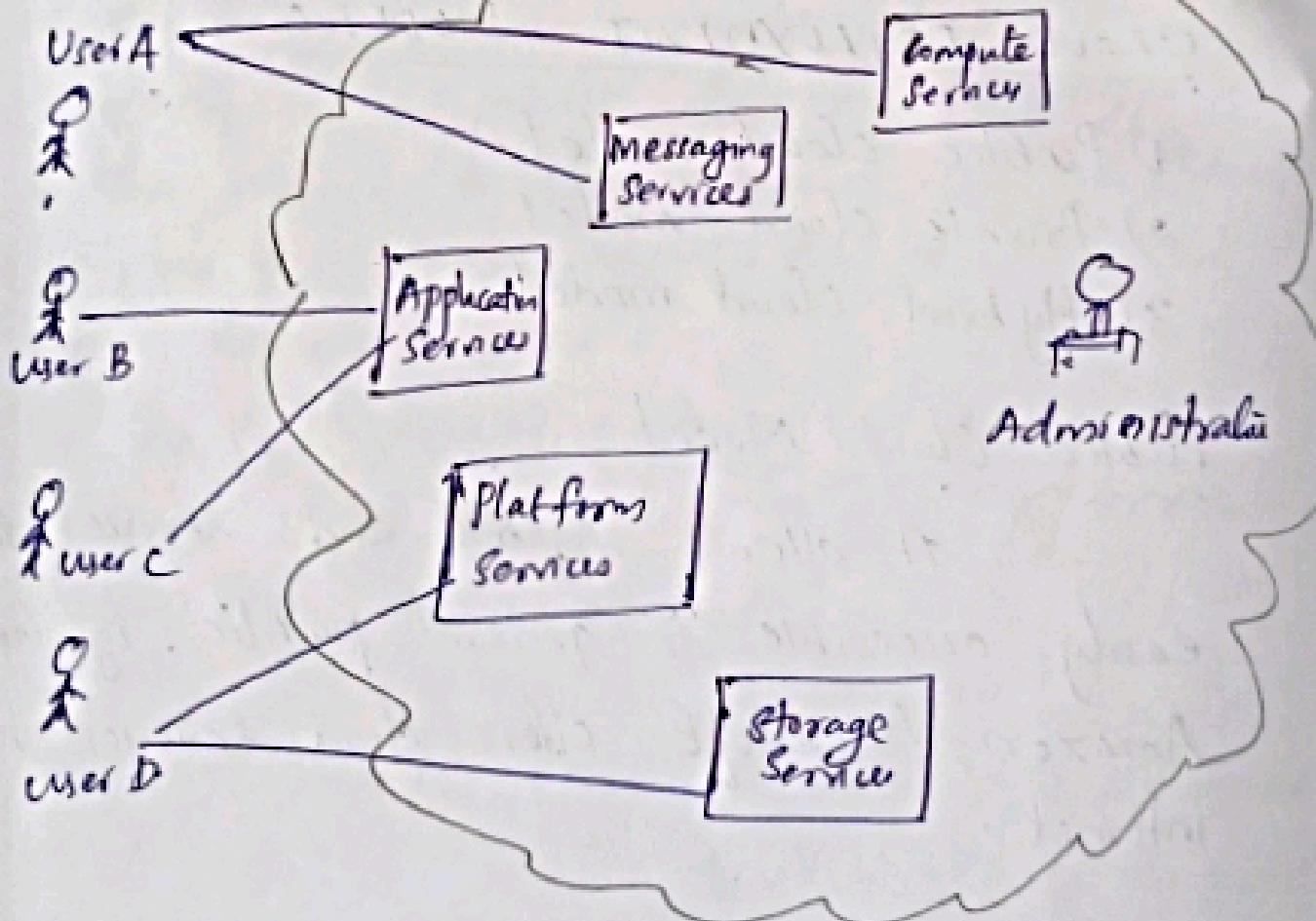
Benefits

- * Cost effective
- * Reliability
- * Flexibility
- * Location Independence
- * Utility Style costing
- * High scalability

Disadvantages

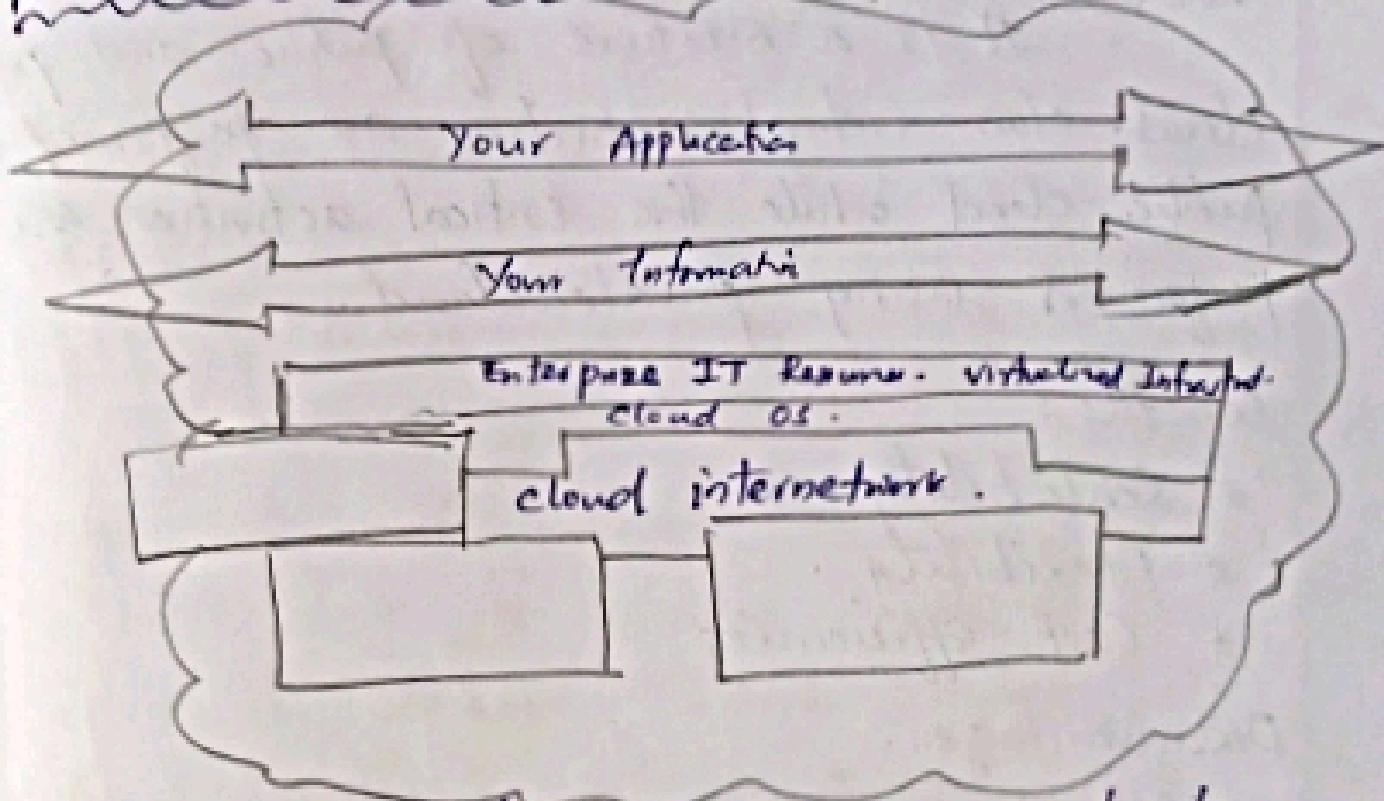
- * Low security
- * Less customizable

Public cloud Model.



Private cloud Model

private cloud .



It allows systems and services to be accessible within an organization. The private cloud is operated only within a single organization. However, it may be managed internally or by third-party.

Benefits

- * Higher security & privacy .
- * More control .
- * Cost and energy efficiency .

Disadvantages

- * Restricted Area .
- * Inflexible Pricing .
- * Limited Scalability .
- * Additional Skills .

Hybrid Cloud Model

It is a mixture of public and private cloud. Non critical activities are performed using public cloud while the critical activities are performed using private cloud.

Benefits :

- * Scalability .
- * Flexibility .
- * Cost efficiencies

Disadvantages .

- * Networking issues ..
- * Security compliance .
- * Infrastructural dependency .

Different Service Providers

I Amazon Web Services (AWS)

features :

- * Aws is scalable because it has an ability to scale the computing resources up or down according to the organization's demand.
- * Aws is cost-effective as it work on a pay -as -you -go pricing model.
- * It provides various flexible storage options.
- * It offers various security services such as infrastructure security , data encryption ,

monitoring and logging, identity & access control, penetration testing and DDoS attacks.

* It can efficiently manage and secure windows workloads.

i) Microsoft Azure (Windows Azure)

It supports various OS, databases, programming languages, frameworks, that allow IT professionals to easily build, deploy and manage applications through a worldwide network. It also allows users to create different groups for related utilities.

Features:

* Microsoft Azure provides scalable, flexible and cost-effective.

* It allows developers to quickly manage applications and websites.

* It manages each resource individually.

* Its IaaS infrastructure allows us to launch a general-purpose VMs in different platforms such as Windows & Linux.

* It offers a Content Delivery System (CDS) for delivering the Images, videos &, audios & applications.

III Google Cloud platform

It is a product of google. It consists of a set of physical devices, such as computers, hard disk drives and virtual machine. It also helps organizations to simplify the migration process.

Features:

- * It includes various big data services such as Google BigQuery, Google Cloud DataProc, Google Cloud DataLab and Google Cloud Pub/Sub.
- * It provides various services related to networking including Google Virtual Private Cloud (VPC), Content Delivery Network, Google Cloud Load balancing, Google Cloud Interconnect, and Google Cloud DNS.
- * Scalable & high performance.
- * Provides serverless services such as messaging, Datawarehouse, Database, Storage, Data Processing and Machine learning.
- * It provides a free cloud shell environment with Boost mode.

IV IBM Cloud Services

It is an open-source, faster and more reliable platform. It is built with a suite of advanced data and AI tools. It offers various services such as Infrastructure as a Service, SaaS & PaaS. You can access its services like compute power, cloud data & Analytics, cloud use cases and storage networking using internet connection.

Features:

- * improves operational efficiency.
- * its speed & agility improve the customer's satisfaction.
- * it offers Infrastructure (IaaS), PaaS, SaaS.
- * it offers various cloud comm' services to our IT environment.

V VMWare

- * Pay-as-per-use model & monthly subscription.
- * it provides better customer satisfaction by protecting the user's data.
- * it can easily create a new VMWare SDPC - Software Defined Data Center cluster on AWS cloud by utilizing a RESTful API.

- * It provides flexible storage options. We can manage our application storage on a per-application basis.
- * It provides a dedicated high-performance flow for managing the application traffic and also supports multicast networking.
- * It eliminates the time and cost complexity.

VI Oracle Cloud

- * Provides various tools for build, integrate, monitor & secure the appn.
- * Its infrastructure uses various languages including Java, Ruby, PHP, Node.js.
- * It integrates with Docker, VMware & other DevOps tools.
- * It offers customizable virtual cloud networks, firewalls & IP addresses to securely support private network.

VII Red Hat

It is an open standard & desktop virtualization platform produced by Redhat.

- * provide secure, certified & updated container image via Redhat Container Catalog.
- * Support 16 VMs, each having upto 256 GB of RAM.