Unit-4:

Data intensive computing, Map reducing programming - what is Data intensive computing. characteristics, challenges and Historical prospective. Technologies for data intensive computing - storage systems, programming platforms.

cloud Applications - scientific application, Health care ECG Analysis in the cloud, Social networking media applications, multi-player online gaming.

Unit-5:

cloud platform in industry and cloud applications -

1. Cloud platform in industry, Amazon web services, compute services, storage services, communication services, Additional services

Google App Engine Architecture and core concep Application life cycle, cost model observations Microsoft Azure, Azure core concepts, SQL Azure, Windows Azure, platform applications

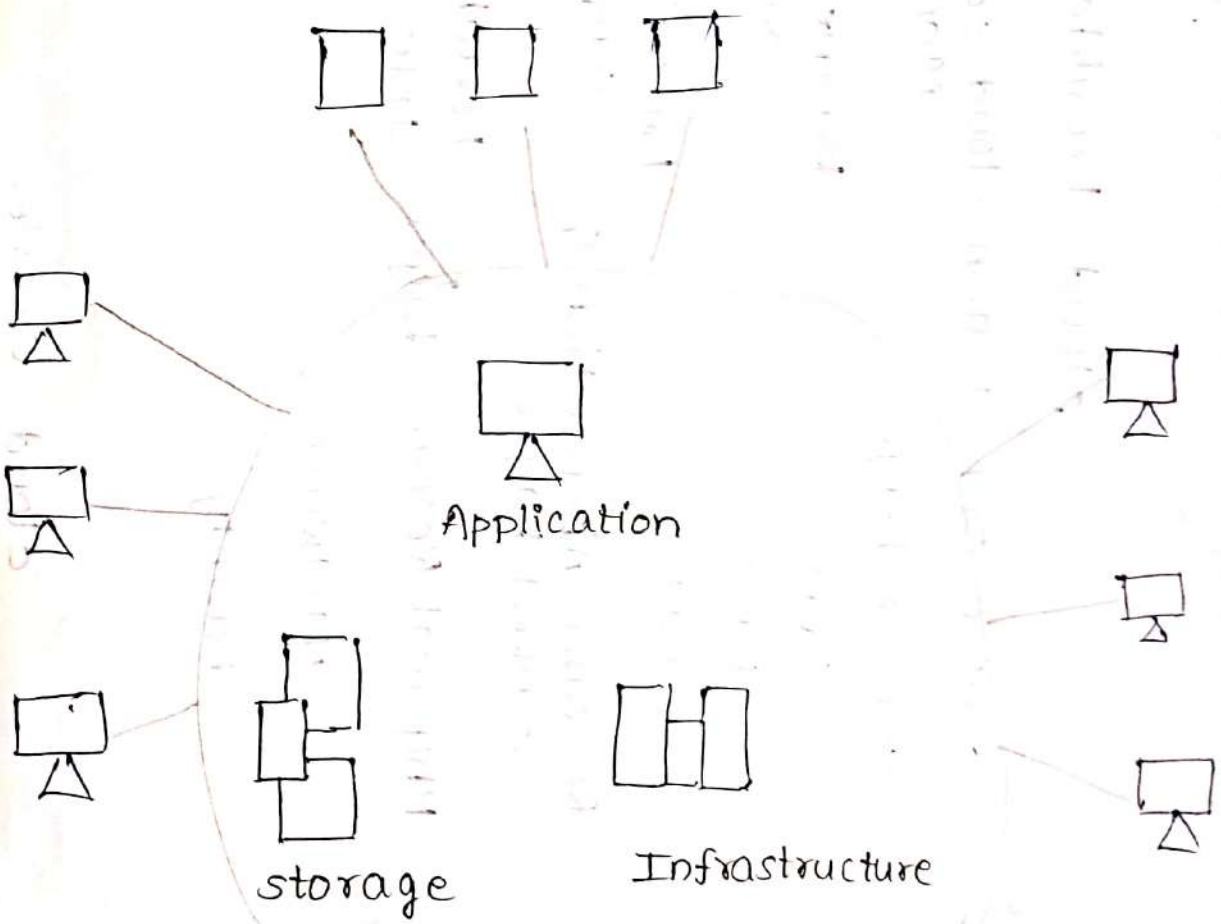
Unit-1

cloud:

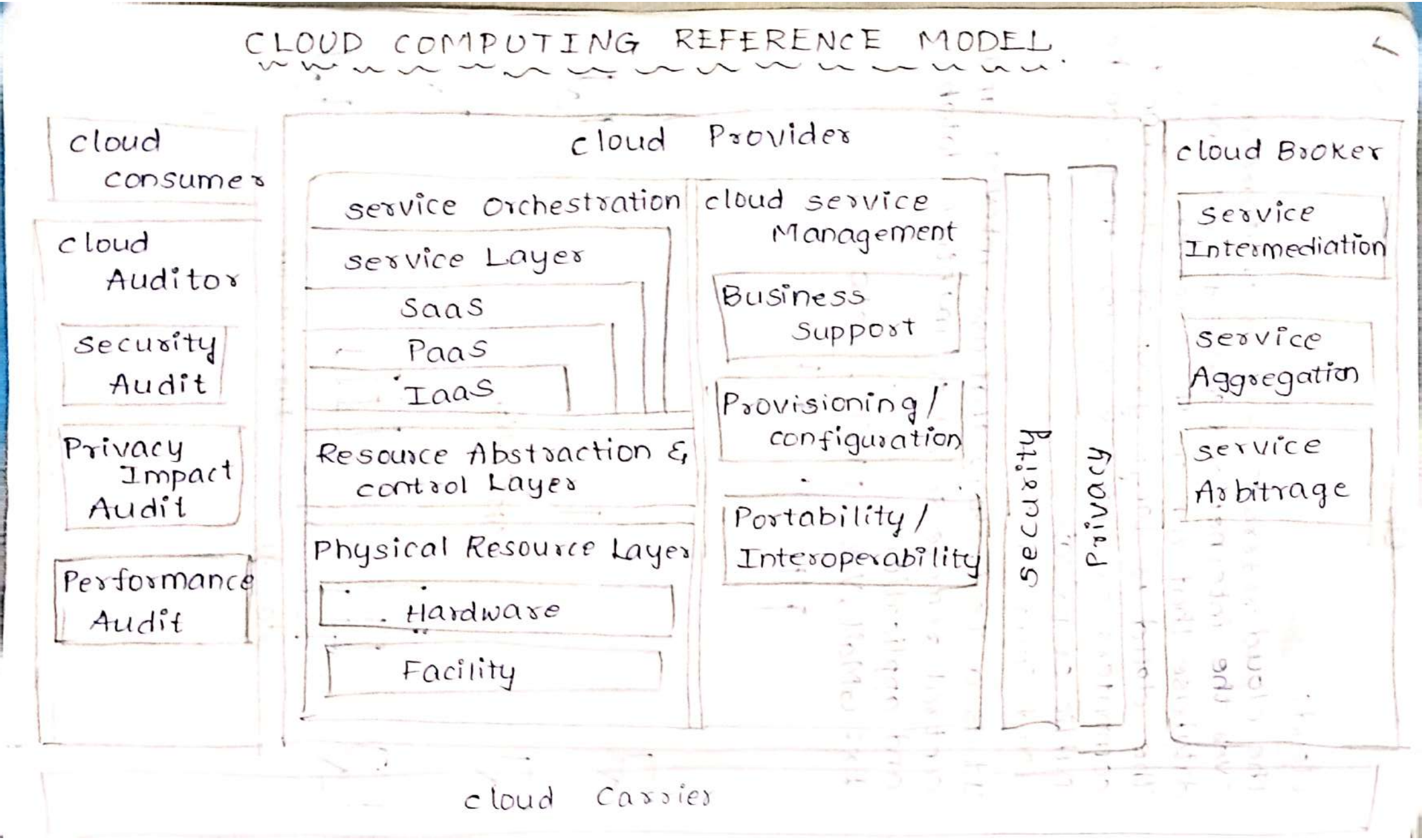
The cloud refers to servers that are access over the internet and the software and database that run on those servers.
The cloud is large group of interconnected computers or network servers. They can be public or private.

cloud Computing:

It is a technology that uses internet and central remote server to maintain database and applications.
Ex: GMail, Yahoo Mail, ... etc.

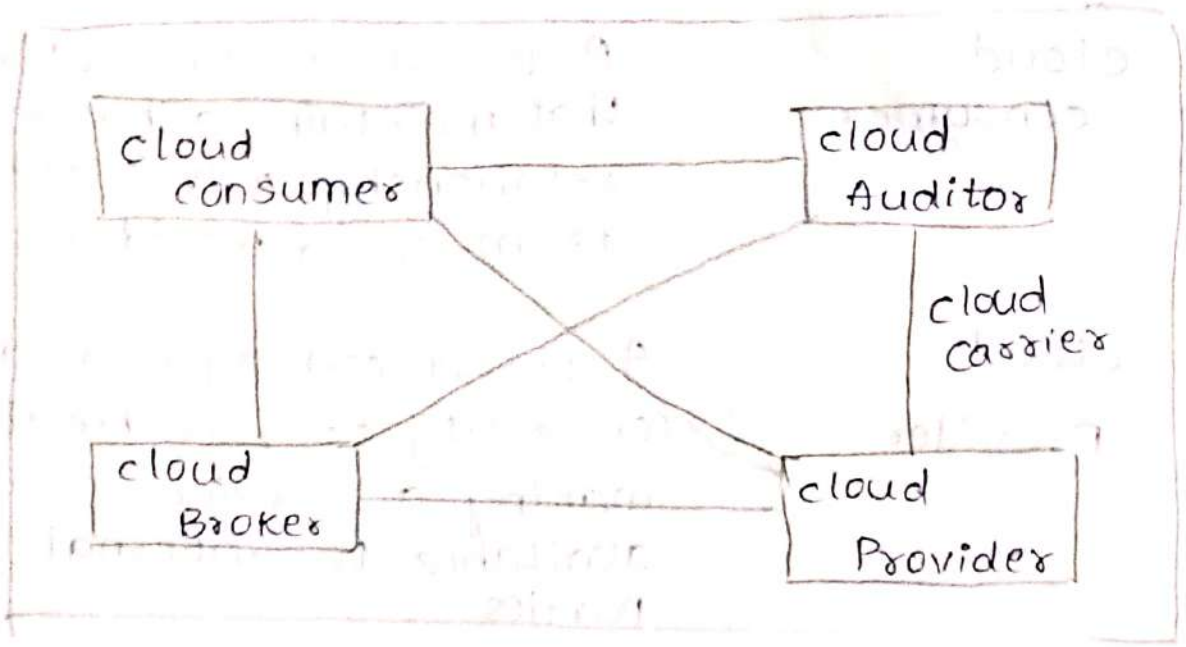


CLOUD COMPUTING REFERENCE MODEL



cloud consumer	A person or organization that maintains a business relationship with users from cloud provider
cloud Provider	A person (or) organization (or) entity responsible for making a service available to internal parties
cloud Broker	An entity that manages the use performance and delivery of cloud services and negotiates relationship between cloud provider & cloud consumer
cloud carrier	An intermediary that provides connectivity and transport of cloud services from cloud provider to cloud consumer
cloud Auditor	The party that connects conducts independent assesment of cloud services information, system operations, performance and security of the cloud implementation.

Interaction among the actors:



The cloud consumer may request cloud services from cloud Provider directly or through cloud Broker.

A cloud Auditor conducts independent audits and may contact the others to collect necessary information.

cloud carriers provide the connectivity and transport of cloud services from cloud Provider to cloud consumer.

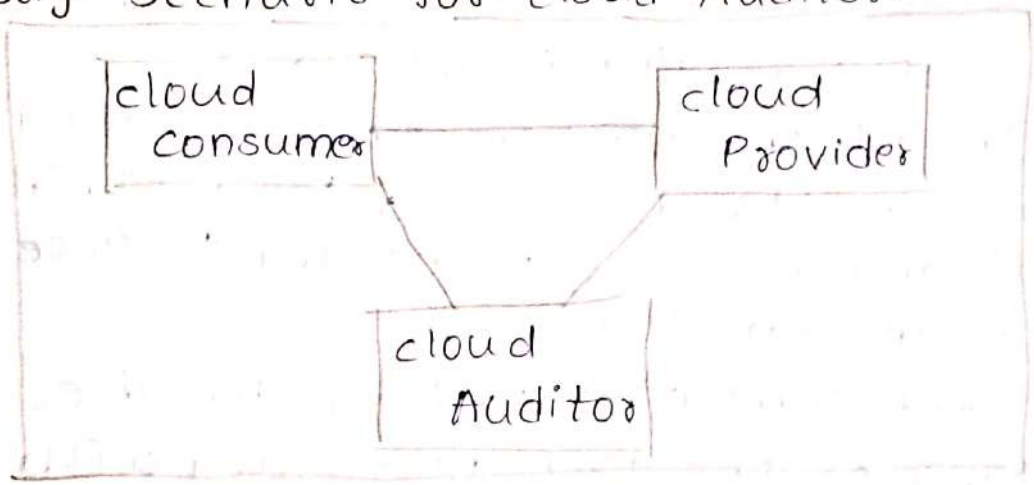
Usage scenario for cloud carriers:

The cloud provider participate in; and arranges for two unique service level Agreement (SLA). One with cloud carrier and the other with cloud consumer.

A cloud provider arranges service level agreements with encrypted connections to ensure the cloud services are consumed at an consistent level according to the contratual obligation with the cloud consumers.

In this case, the provider will specify its requirements on capability, flexibility and functionality in SLA2. In order to provide essential requirements in SLA1.

Usage Scenario for cloud Auditor:



A cloud service, a cloud auditor conducts independent assessment of the operation and security of cloud services implementation. The audit may involve with both the cloud consumer and cloud provider.

characteristics of cloud computing:

- cloud computing is user-centric:
  once users are connected to the cloud what ever is available (stored) in cloud as a document message, image, application it becomes users own. Users can also share it with others
- cloud computing is task-centric:
  It focus on the application for users on what users need to do and how the application can be done for the users
  Ex: Animation, collage,
- cloud computing is powerful:
  connecting 100s and thousands of computers together in a cloud creates wealth of computing power which is impossible with a single desktop or PC.

- cloud computing is accessible:
The data is stored in the cloud, users can instantly retrieve more information from multiple repositories. Here, we are not limited to a single source of data
- cloud computing is intelligent:
with all the various data is stored on the computer in a cloud. Data Mining and analysis are necessary to access the information.
- cloud computing is programmable:
Many of the task are necessary with cloud computing it must be automated. cloud must be replicated on other computer in the cloud. If that one computer goes offline the cloud's programming automatically redistributes the computa data to new computer in a cloud.

Ex: soft cloud computing Applications.-
Google docs, spread sheets, GMail, Google calendar etc.

Pro's and Con's of cloud computing:

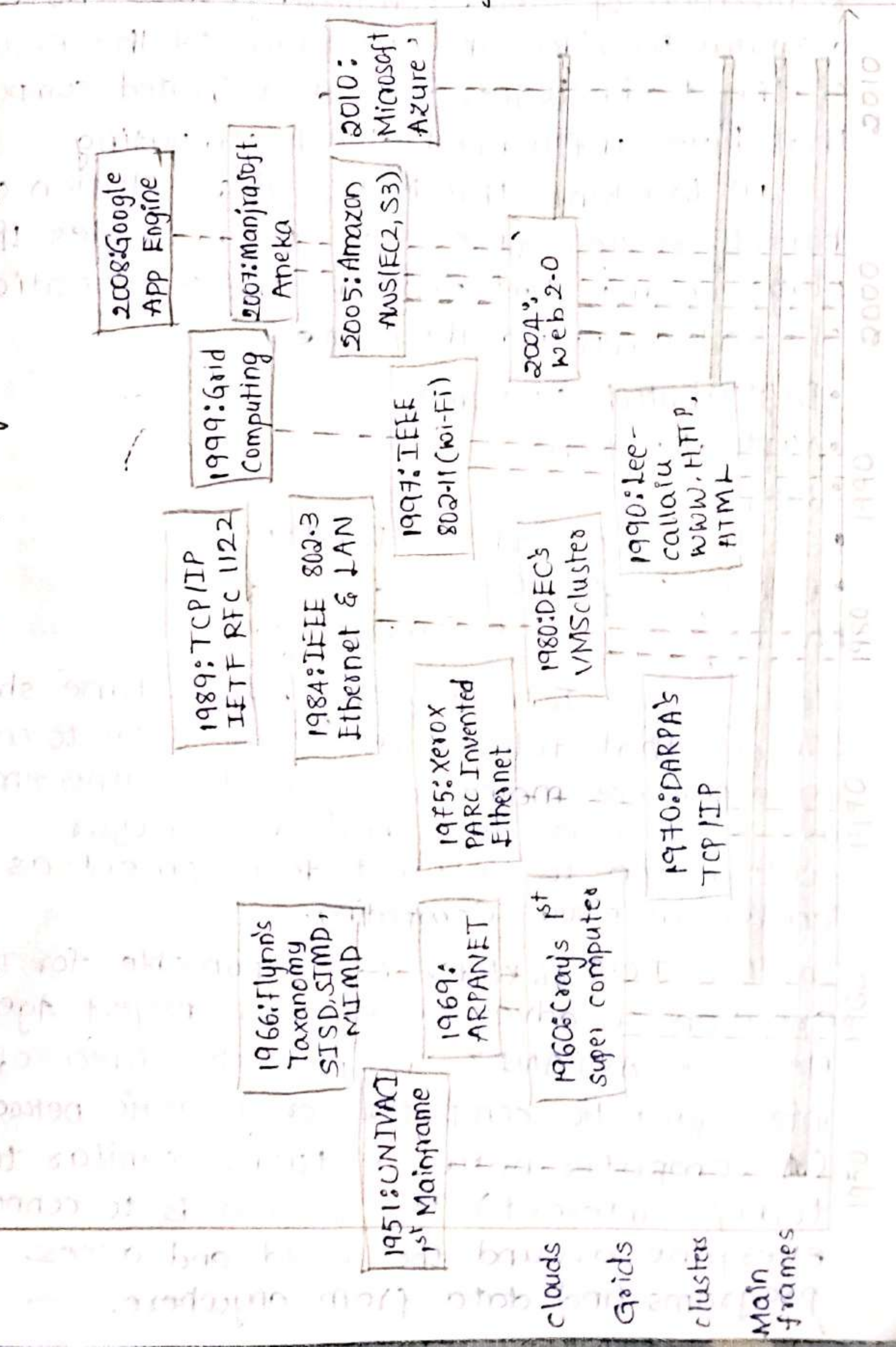
Advantage:
- Lower cost computers for users
- Improved performance
- Fewer maintainence issues
- Lower software cost
- Instant software updates
- Lower IT infrastructure cost
- Increased computing power
- Unlimited storage capacity
- Increased data safety
- Easier group collaberation

• Universal access to documents.

Disadvantages:

- Requires constant internet connection
- Doesnot work with low-speed connections
- Features might be limited
- Stored data might not be secured.
- Problem will arise if data loss occurs.

Evolution of Distributed computing Technologies.



The idea of renting computing [illegible] leveraging large distributed computing facilities has being around for long-time. It takes back to the date of the main frames in the early 50's. From there on the technology evolve and refined. This process has created a series of favourable conditions for the realization of cloud computing. The above diagram provides an overview of the evolution of the technologies for distributed computing that have influenced cloud computing.

In tracking the historical revolution coe briefly review five core technologies that plays an important role in the realization of cloud computing. They are

- Distributed systems
- Virtualization
- Web 2.0
- Service oriented computing
- Utility computing.

History of cloud Computing:

Early 1960s - John McCarthy has a time sharing concept that follows a organization to use an expensive mainframes at the same time. This machine is described as a major contribution to internet development as a leader in cloud Computing.

In 1969 - J.C.R Licklider is responsible for the creation of advanced Research project Agency Network (ARPANET) propose the idea of inter galactic computers or galactic network (A computer network turns similar to today's internet). His vision is to connect everyone around the world and access programs and data from anywhere.

In 1970s - Usage of tools, such as VMware, for virtualization. more than one operating system can be run in an separate environment simultaneously in an different operating system It was possible to operate a completely different computer

In 1997 - Prof Ramnath chellappa in dollars seems to be known first to define cloud computing. In which computing boundaries are defined solely. on economic rather than technical limits alone.

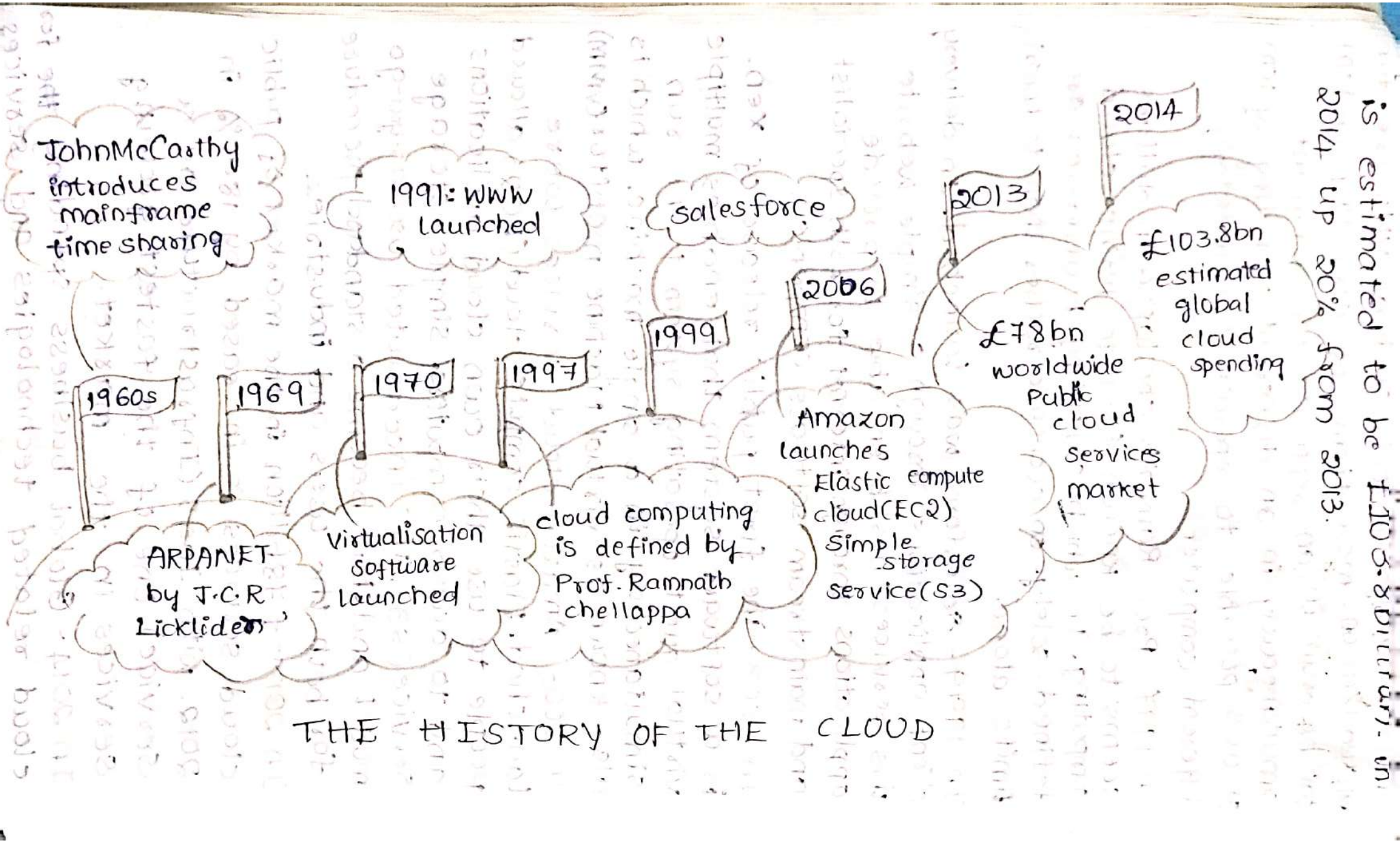
In 1999 - Salesforce was launched. In delivery client applications through a simple website this services has been able to provide applications through internet for both specialist and mainstream software companies.

In 2003 - The first public release of Xen. is a software system that enables multiple virtual guest operating system to be run simultaneously in a single machine. which is also known as virtual machine monitor (VMM)

In 2006 - Amazon cloud services were launched. Elastic compute- cloud (EC2) allowed people to use their own cloud applications and to access computers. simple storage service (S3). This incorporated user-as-you-go model and has become a standard procedure for both the users and industries.

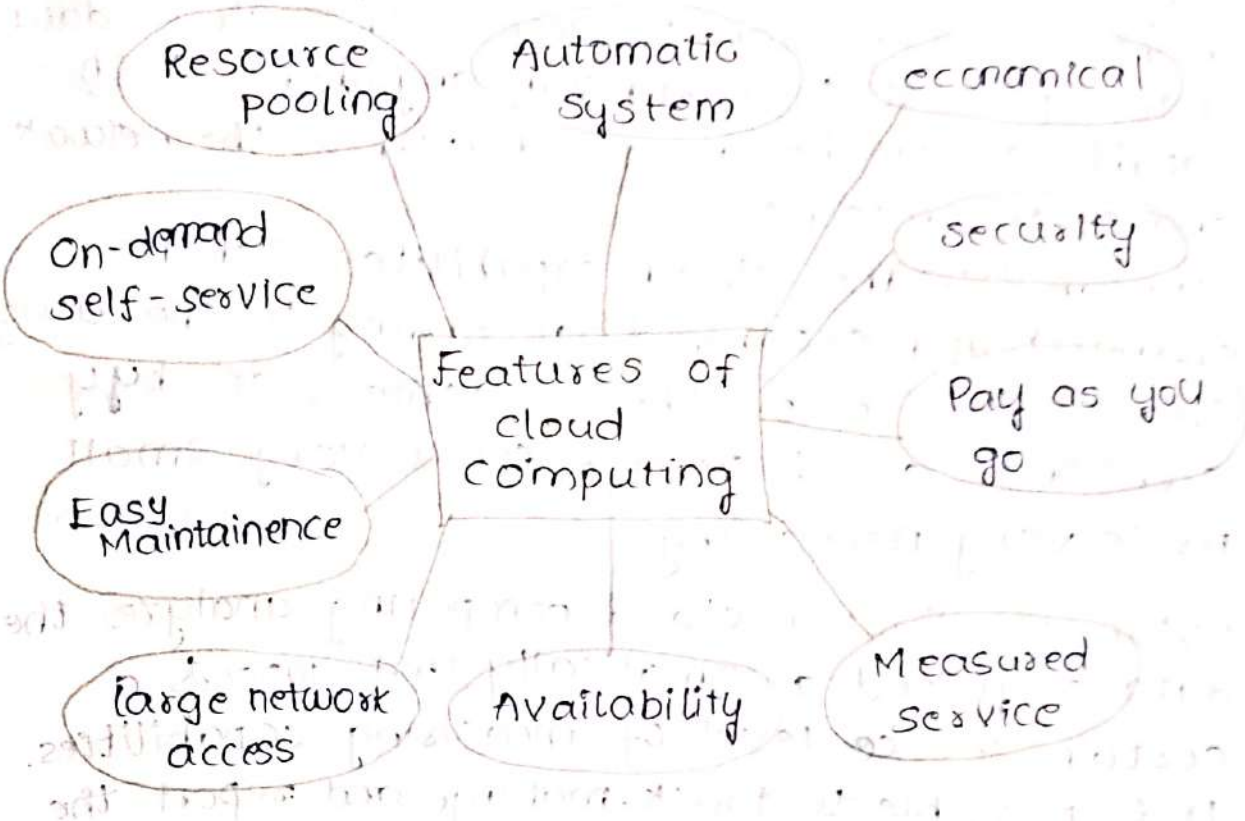
In 2013 - £78billion in the market of public cloud services is increased by 18.5% in 2012. with Iaas (Infrastructure as a service). One of the fastest growing services in the market.

In 2014 - Global business spending the for cloud related technologies and services



is estimated to be £103.8billion in 2014 up 20% from 2013.

Features and Benefits of cloud Computing:



Resource Pooling: this means that the cloud Provider use a multi learner model to deliver computing resources to various customers. There are various allocated (entry ass) and reassign physical and virtual resources on customer demand. In general, the customer has no control of information about the location of resources provided But can choose location on a higher level of extraction

On-demand self service: this is one of the main useful advantage of cloud computing as the user can track server uptimes, capabilities, a network storage ongoing basis. The user can also monitor the functionalities with this feature.

Easy Maintainence: the servers are managed easily wh and the downtime is small and there are no downtimes except in some cases. cloud computing offers an update everytime that increasingly enhances it. The updates are more system friendly and operated with patched

bugs faster than older ones.

Large Network Access: The user may user defines an internet connection to access the cloud data or to upload it to cloud run anywhere. Such capabilities can be accessed across the network and to the internet

Availability: The cloud capabilites can be changed and expanded according to the usag This reviews helps the customers to buy additional cloud storage for a very small price very necessary.

Automatic System: cloud computing analyzes the data required automatically and supports a certain service level of measuring capabilities. It is possible to track, manage and report the usage. It provides both the host and the customer with accountability.

Economical: It is one-off the investment since the company (host) is required to buy the storage, which can be made available to many companies, which save the host from monthly or annual costs. only the amount spent on the basic maintainence and some additional costs are much smaller.

Security: cloud security is one of cloud computing's best features. It provides a snapshot of the data stored so that even if one of the servers is damaged, the data cannot get lost. The information is stored on the storage devices, which no other person can hack or use. the service of storage is fast and reliable.

Pay as you go: Users only have to pay for the service or the space in cloud computing. No hidden or additional charge to be paid is liable to pay. The service is economical and

space is often allocated free of charge.
Measured services: cloud computing resources that the company uses to monitor and record. This use of resource is analyzed by charge per use capabilities. This means that resource use can be measured and reported by the services provider, either on the virtual server instances running through the cloud. You will receive a models pay depending on the manufacturing company's actual consumption.

Challenges Ahead:

1. security and Privacy
2. Interoperability and Portability
3. Reliability and Flexibility
4. Cost
5. Lack of Resources
6. Downtime
7. Dealing with multi-cloud environment
8. cloud Migration
9. vendor lock-in
10. Privacy and legal issues.

1. The cloud data must be confidential. The cloud Provider must take security measures necessary to secure customers data. Securities are also customer's liabilities. Because they must have good password and update our passwords on regular basis. If the data is outside the firewall certain problems may occur that the cloud provider can eliminate. Hacking and malware are one of the biggest problem because they can affect the customer data loss can result the encrypted file system. and several other issues are disrupted.

2. Immigration services in and out shall be provided to the customer no bond period shall be allowed. As the customers can be hampered. remote access is one of the cloud obstacle removing, the ability from the cloud providers to access the cloud from anywhere.

3. They are indeed a difficult task for cloud customers which can eliminate the leakage of data provided to the cloud and customers trust worthiness. To overcome this challenges third party services should be monitored and the performance depends upon the company supervised.

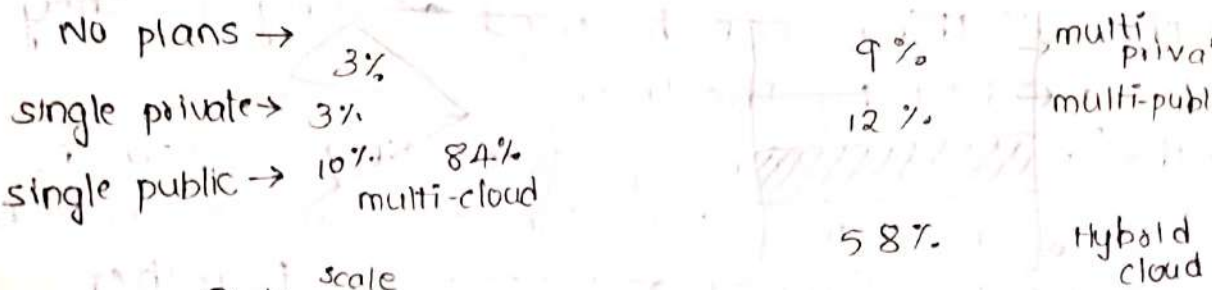
4. cloud computing is affordable but it can be expensive sometimes to change the cloud on customers demand.

5. A cloud industry also faces lack of resource and expertise with many businesses to overcome it by hiring new, more experience employees this employees will not only solve the challenges of businesses but will also try existing employees to benefit the company.

6. It is the most popular challenge as a platform is free from downtime is guaranteed by the cloud provider. Internet connections also play a major role as it can be a problem if a company has non trustworthy internet connections because it faces downtime

7. According to the right scale report almost 84% of enterprises adopt multi-cloud approaches and 58% have their Hybrid cloud

approach mixed with both public and private clouds
Interms of IT infrastructure have more difficulty in long-term predictions about the Enterprise cloud strategy



Right scale side report 2019

future of cloud computing. technologies. Professionals have also suggested the top strategies to address this problem such as re-thinking processors, training personals, tools, active vendors, creation management and the studies.

8. It is very simple to release a new app in the cloud transferring existing app to a cloud computing environment is harder.
9. The problem with vendor lock-in cloud computing includes clients dealing reliant on the implementation of single cloud Provider. and not switching to another vendor without any significant cost regulatory restrictions or technological in-compatabilities in the future.
10. The main problem regarding cloud privacy or data security is data breach.

Vision of cloud Computing:

cloud computing means storing and accessing the data and program on remote server. It is also refered to as that are hosted on internet instead of computers hardware or local server. It is also referred as internet based computing. The main vision of cloud computing are as follows.

* It provides the facility to provision virtual hardware and run time environment and services to the person having money.
* This all things can be used as long as they are needed by the user.
* The ~~poll~~ whole collection of computing system is transformed into collection of utilities which can be provisioned and composed together with no maintainence cost.
* The long term vision of cloud computing is that IT services are preeded as utilities in a open market without technological and legal barriers.
* The existence of such market will enable the automation of discovery process and its integration into its existing software system
* The cloud Provider can also become a consumer of competition services in order to fulfill its promises to customers.
* The cloud Provider can also be a buyer of competetive services to fulfill the promises to customers.

Distributed Systems:

It is a computer concept that refers most of the time to multiple computer systems that work on a single problem. A single problem in distributed computing is broken into many parts and different computers solve each part. While they are interconnected they can communicate to each other & resolve the problem.

The ultimate goal of distributed computing

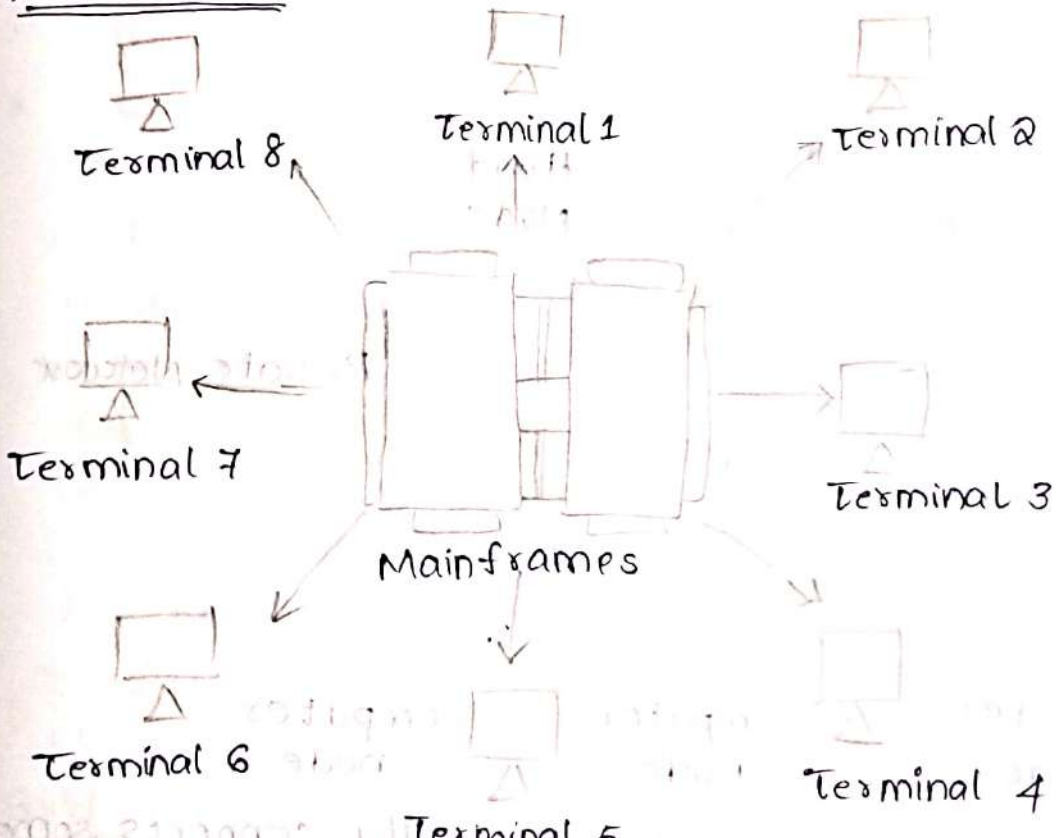
is to improve the overall performance through cost efficiency, transparent and secure connecti-ons between user and IT resources.

Distributed Systems show openness, scalability, transparency, concurrency, continuous availability and independent failures. These characterize clouds to some extent. especially with regard to scalability, concurrency and continuous ability.

cloud computing as contributed three major milestones.

1. Mainframes
2. cluster computing
3. Grid Computing.

Mainframes:



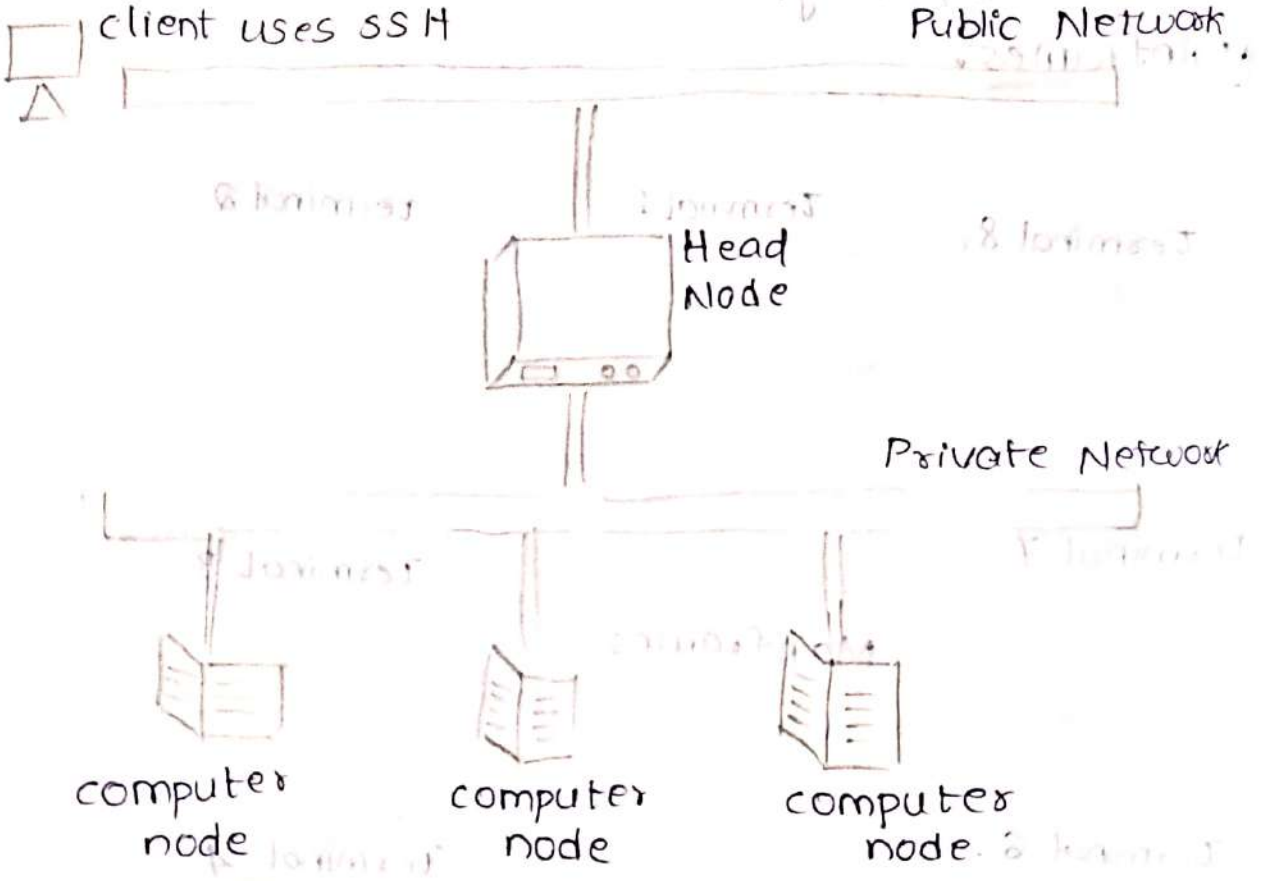
Mainframe is a powerful computer which often service as the main data repository for an IT infrastructure of an organization

- It is connected with terminals or less powerful devices like work stations. It is easier to manage, update and protect the integrity of

data by centralising the data [illegible]
frame repository.

- Main frames are generally used for large scale processes which require greater availability and safety than smaller machines.
- Main frames are primary machines for essential purpose used by large organization bulk data processing. For example census, industry and customer statistics, enterprise resource planning and transaction processing.
- They work in batch mode to support office functions

Cluster Computing:



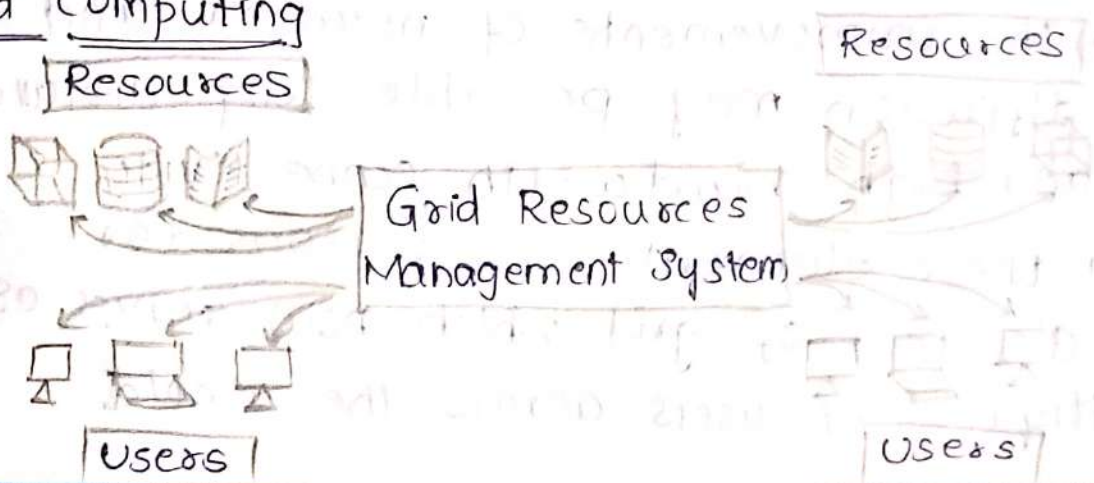
The computer clustering typically connects some computer nodes (Personal computer used as servers ready for download to fast local zone network (LAN).

- computing node activity co-ordinated by the software layer situated in front of nodes that enables the user to access the cluster as a whole.

by needs of [illegible] concept

- cluster computing started as a low cost to use the mainframes at super computers
- This technology advancement that created faster and more powerful mainframes and super computers as eventually generated and increase the availability of cheap computing machines.
- these machines are connected to high band width network and controlled by specific software tools that manage them as a single system.
- From 1980s clustering has become the standard technology for parallel and high performance computing
- cluster technology considerably contribute to the evaluation of tools and main frames for distributed computing. some of them include parallel virtual machine and message passing interface. One of the attractive feature of clustering was that the computational power of computi comodity machines could be leverage to solve problems previously managable by only on expenses super computer more over clusters could be easily extended if more computational power was required.

Grid Computing



- It is a processor of architecture that combines computer resources from different fields to achieve the main purpose
- The network computer can work together on a work task in a grid computing and work as a super computer.
- The grid operates different network task that it can also opesates on specific applications.
- computing grid has multiple user network that needs continuous information for processing requirements.
- Grids are initially developed as an aggregation of geographical clusters by means of internet connection. These clusters belongs to different organization and arrangements were made among them to share the computational power.
- Some reasons are respol possible to diffusion of computing grid

(i) clusters where noud resources are queit common

(ii) they were often under utilize th

(iii) the new problem of requiring computational power going beyond the capobility of single cluster

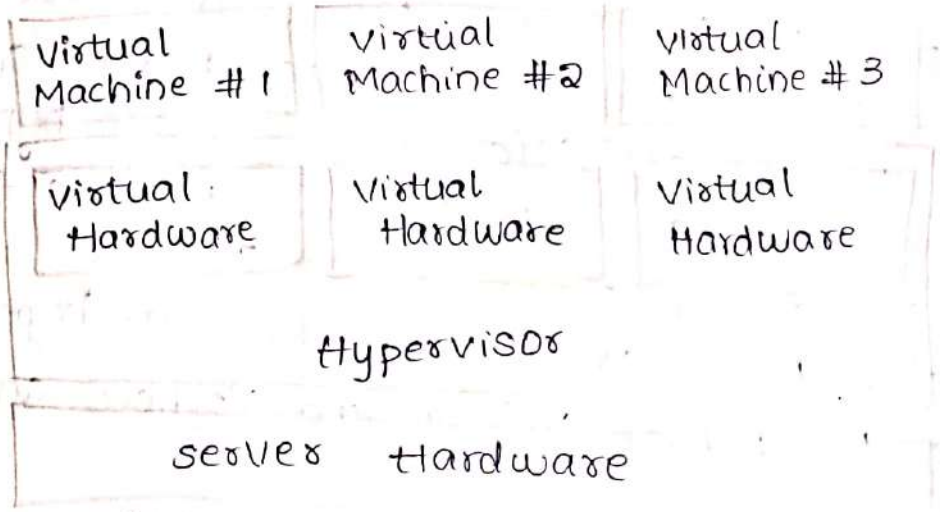
(iv) the improvements of network and diffusion may possible long distance and high bandwidth connectivity

All these elements are reasons for development of grid which now seoves as multiqueue of users across the world.

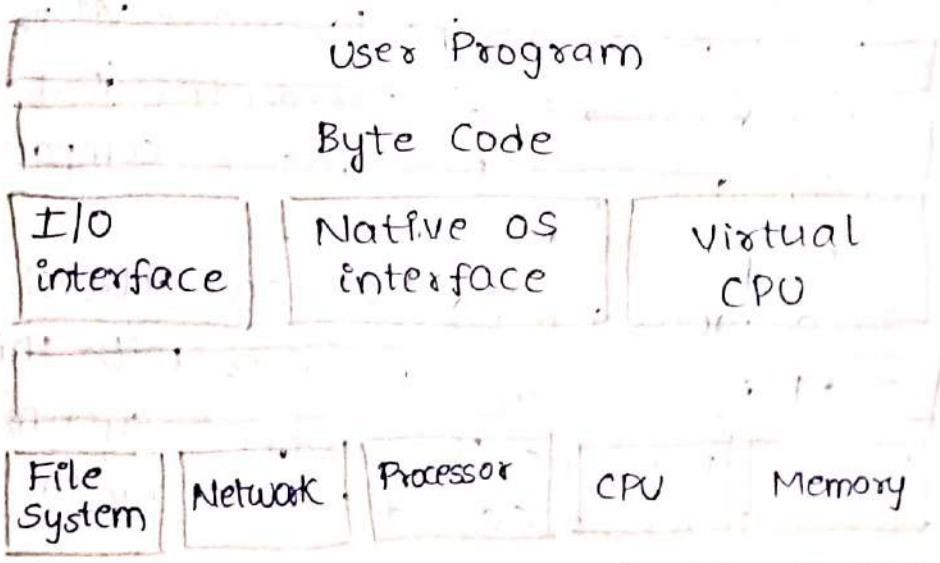
- cloud computing is often considered as a successor of Grid computing. The services made available by the cloud vendor are considered as pay-per-use basis on cloud to implement fully the utility version introduced by Grid computing.

Virtualization:

Virtualization is a process that makes use of physical computer hardware more efficient and effective for the basis of cloud computing. Virtualization uses software to create the layer of extraction over computer hardware enabling multiple virtual computers usually referred as VM's to split the hardware elements from a single computer - processor, memory, storage and more.



A.) Hardware Virtualization



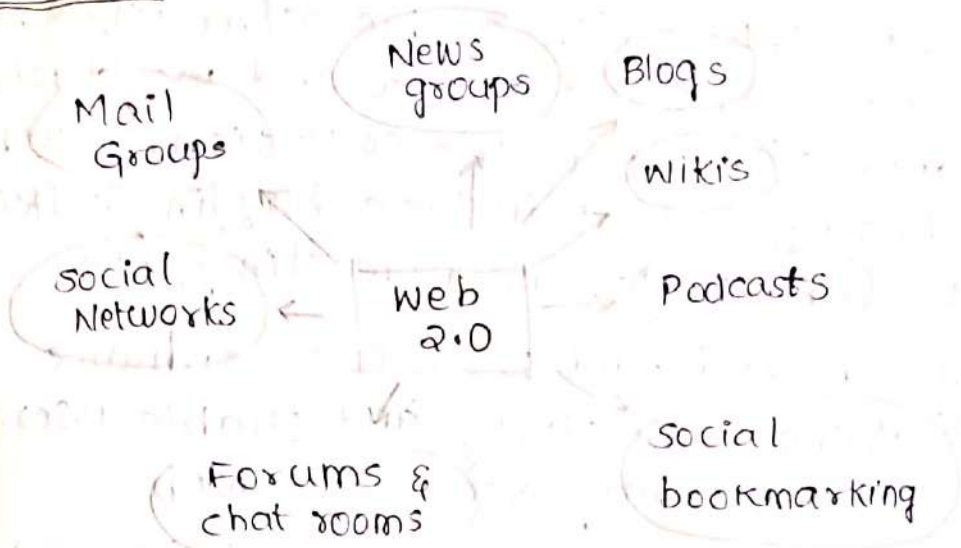
B.) Process virtual Machine Design.

Virtualization facilitates more effective use of physical computer hardware thus allowing large return on hardware investment of an organization. It allows cloud provider to service customers with a own phone physical computing hardware and allows cloud users to purchase only the computer resources they need and scale them cost effectively. It uses a software called Hypervisor in hardware virtualization with the help of virtual machine hypervisor. software is incorporated into the server hardware components. The role of hypervisor is to control the physical hardware that we share between the client and provider. Hardware Virtualization is only done through virtual machine monitors (VMM) to remove physical hardware. there are several extensions to the processes which help to speed up virtualization activities and increase hypervisor performance when this virtualization is done for the server platform it is called server socialization. There are several popular hypervisor including ESX; based VMware and Vsphere and Hyper-V

A high level abstraction of a VM process is the high-level programming language VM process are implemented by means of interpreter just in time compilation achieves performance compared to compiled programming languages.

The Java programming language introduce with the JVM has became popular with this form of virtual machine the ~~dot~~.net system which runs on virtual machine called the common language run-time.

Web 2.0:



The web is the primary interface through which claud computing delivers its services.

- websites cohich emphasize user generated content, user-friendlyness, participatory culture and interoperability for end users and social websites
- web 2.0 is a new concept that was first used in common usage in 1999
- It was first coined by Darcy DiNucci and later popularized during a conference held in 2004 by Tim O'Reilly and Dale Doughtery.
- It is necessary to remember that web 2.0 frameworks deals with only website design and use without placing the designers and technical requirements.
- web 2.0 is the term used to represent a range of websites and applications that permit anyone to create or share the content through online. One key feature of this technology is the ability to people to create to communicate and share.
- It is different from other kinds of sites because it doesnot require the participation of any web design/publishing skills and makes the creation application/communication of work easy for people.

- It represents the evolution of World Wide Web. The web apps which enable attractive data sharing, user-centered design and world wide web collaberation. It is the collection of web based technologies that include blogging, wikis, online networking platforms, podcasting, etc.
- The main concept behind W2.0 is to enhance web applications connectivity and enable users to easily and efficiently access the web
- cloud computing services are essentially web applications that provide computing services on the internet on demand.
- Web 2.0 brings inter-activity and flexibility into web pages which provide enhanced user experience by gaining web based access to all the functions that are normally found in desktop applications.
- This capabilities are obtained by integrating a collection of standards and technologies such as XML, AJAX (Asynchronous Javascript And XML) web services and others.
- Web 2.0 applications and frameworks are used for delivery rich internet applications (RIA) that are fundamentals for making cloud services accessible to the wider public
- This applications definitely contribute to make people more a custom to the use of internet in their everyday lifes and opened the path to the acceptance of cloud computing where even the IT infrastructure is offered to web interface

Service Oriented Computing:

Service oriented is the core reference model for cloud computing. It uses the services as a fundamental component in the creation of applications. This approach adopts the concept of services as main building blocks of applications and system development. It supports the development of rapid, low-cost, flexible, interoperable applications and systems.

A service is an abstraction representing a self describing platform components that perform any function. This can be anything from a simple function to a complex business process.

A peice of code that performs a task virtually can be turned into a service and expose its functionalities through a network accessible to a protocol

A service is suppose to be loosely coupled, reusable, programming language independent and location transparent

Loose couples allows service to serve different scenarios more easily and makes them reusable.

Services are composed and aggregated into service oriented architecture (SOA) which is logical way of organizing software systems to provide end users or entities distributed over the network with services.

Software oriented computing introduces and diffuses two important concepts which are also fundamentals of cloud computing

1. Quality of Service (QoS)
2. Software as a Service (SaaS)

QoS: It identifies a set of functional and non-functional attributes that can be used to evaluate the behaviour of services from

different prospectives

=> This could be performance-metrics such as response time, security attributes, transactional integrity, reliability, scalability and availability.

=> QOS requirements are established between and client and provider between service ~~tabel~~ level agreement. That identifies the minimum value for QOS attributes that need to be satisfied

Saas:

It introduces a new delivery model for applications. It has been inherited from the world of application service providers (ASP's)

=> This deliver software service based solutions across the wide Area Network (WAN) from data center and make them available on subscriptions or rental basis.

=> The ASP is responsible for maintaining the infrastructure and making available the application and the client is free from maintainence cost and difficult upgrades.

=> The Saas approach reaches its full development with service oriented computing where loosely coupled software components can be exposed and praised similarly rather than entire application.

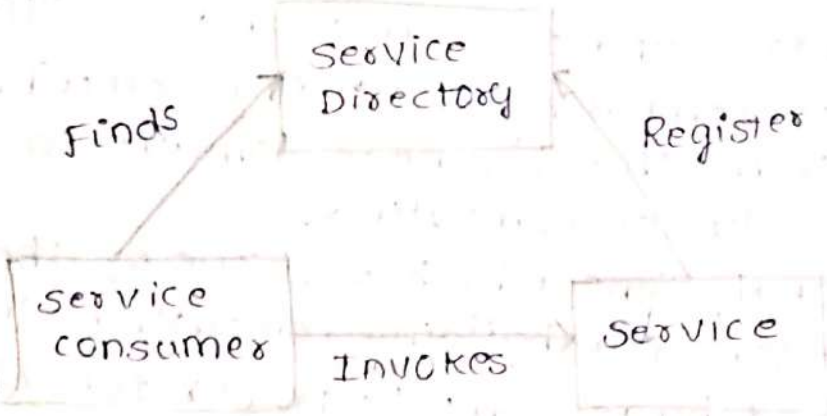
-> The most popular expressions of service oriented is represented by web services. The interface of web services can be programmatica infer by metadata expressed through web service description language (WSDL). This is an XML language that defines the characteristic of the service & in all the methods together

=> The interaction with web services happen through simple object access protocol (SOAP)

=> web services technologies have provided the

composition straight forward and integrated with the mainstream world wide web environment

Service Oriented Architecture:



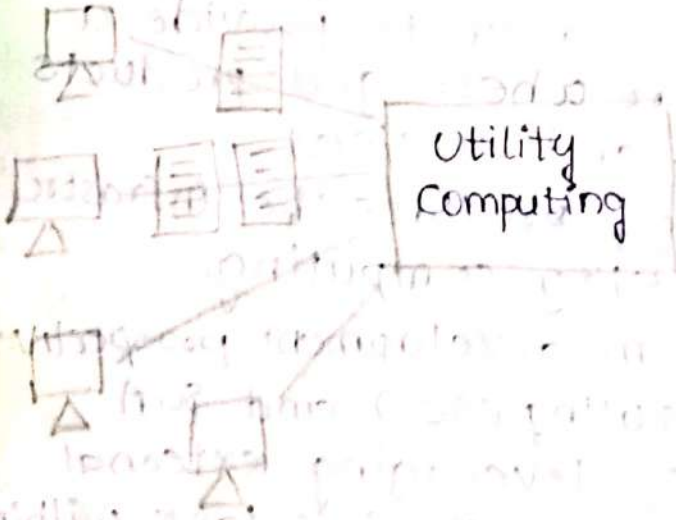
⇒ services are discrete software components implemented using well-defined interface standards

⇒ service is deliver to directory or register until it is created and validated to allow other developers to access the service

⇒ It provides repository that contains information on the published service

⇒ The services are distinct entities and can be invoked without a platform or programming language known at run time.

Utility Oriented Computing:



- Utility computing is a vision of computing defines a service provisioning model for compute services in which resources such as storage compute power applications and infrastructure

are packaged and offered on ~~pay~~ per use basis

- The business model introduced with utility computing brought a new requirement and lead to the improvement of mainframe technologies and additional features such as operating systems, Process control, end user metering facilities.
- The idea of computing a utility remains an extended from the business domain to the advent of cluster computing.
- computational sigs which was one of the major driving factors for building computing clusters still required huge compute power for addressing grand challenge problems and satisfy their computing needs internally.
- The diffusion of the internet and the web provided means to realize utility computing at world wide scale through simple interfaces. grids
- computing tricks provide a planet scale distributed computing infrastructure that was accessible on demand.
- computing grid brought the ~~conc~~ utility computing to the next level which is being accessible on wider scale it is easier to provide a trading infrastructure where grid products are stored, computed and serviced
- E-commerce technology provides the infrastru-cture support for utility computing.
- Applications and System development prospectives service oriented compating (SOC) and SOA introduced the idea of leveraging external services for performing a specific task within a software. This services are accessible through internet and they are charged according to the usage.

- All these factors contribute to the development of utility computing and offer important steps in realization of cloud computing in which computing utilities vision comes to a full expression.

Building cloud Computing Environment:

The creation of cloud computing environment encompasses both the development of applications and system that leverage cloud computing solutions and the creation of frameworks, platforms and infrastructure delivering cloud computing services

i) Application Development:

The powerful computing model that enables users to use applications on demand is provided by cloud computing. One of the most advantageous applications in this features are web-applications

They are mostly influenced by the work load generated by users on demand.

- With the fusion of web 2.0 technologies the web has become a platform for developing rich and complex applications including enterprise applications.
- This applications are characterized by complex process that are triggered by interaction with users and by interaction between the multiple steps behind the web frontend.
- The another application that cloud potentially gained considerable by resource intensive application. this can either data-intensive or compute-intensive applications
- In both the cases we consider amount of resources required to complete execution in a reasonable time frame.
- Large amount of resources is not needed constantly for long duration. The resource-intensive applications

are mostly characterized by batch processin
- The solution for this is cloud computing. It is a demand on dynamic scaling across the entire stack of computing
- This is achieved by
  a) providing methods for renting compute power storage and networking.
  b) offering run-time environment design for scalability and dynamic sizing.
  c) Providing application services the behaviour of desktop applications both are completely hosted and managed by provider.

ii) Infrastructure and System Development:

- Distributed computing, virtualisation, service orientation and web 2.0 from the core technologies enabling the provising of cloud services
- Distributed computing is the foundational model for cloud computing because cloud systems are distributed systems.
- The characteristics is pretty on demand constitute the major challenges for engineers and developers The cloud computing solutions mostly address at the middleware. layer of computing system.
- Infrastructure as a Service (IaaS) solution provide the capabilities to add or remove resources but it is deployed to the system and the infrastructure is scalable to use such opportunities with wisdom and effectiveness.
- Platform as a Service (PaaS) is a solution embedded to there core offering algorithms and rules that control the provising process and the lease of resources. This can be completely transparent to the developers.
- Web 2.0 technologies consist the interface through which cloud computing services are manage and provision. web browsers and web servers become

the primary access point to cloud computing systems.

- Virtualization is another fundamental element and this technology is the core feature of infrastruc-ture used by cloud providers.
- These are all considerations that influence the way in which program applications and systems are based on cloud computing technologies.

Computing Platforms and Technologies:

Development of cloud computing applications happens by leveraging platforms and frameworks that provide different types of services.

1. Amazon Web Services (AWS):

- AWS offers infrastructure as a service ranging from virtual compute storage, networking to complete computing task.
- AWS is mostly known for its storage and compute on demand services named as Elastic Compute cloud (EC2) and Simple Storage service (S3)
- EC2 offers customizable virtual hardware to the end users which can be utilized as the base infrastructure for deploying computer systems on the cloud.
- S3 is well-ordered into buckets which contain objects that are stored in binary form and can be grown with attributes, end users can store objects of any size from basic file to full disk image and have them retrieval from anywhere.
- In addition EC2 and S3 are wide range of services can be leverage to build virtual computing systems including networking support, cache systems, DNS, Database support and other.

2. Google App Engine:

- It is scalable runtime environment frequently dedicated to execute web applications.
- This utilize the benefits of large computing

infrastructure of google to agriculture as for the demand.

- This utilize the benefits of large computing]
- App engines offers both secure execution environment and a coluection of which simplifies the development of scalable and high performance web applications.
- This services include memory cache, scalable data store, job queues and messaging.
- currently, the supported programing languages are python, java.

3 Microsoft Azure: It is a cloud operating system and a platform which users can develop the applications in the cloud.

- Azure provides a set of services that supports storage, networking, caching, content-delivery and others.

4 Hadoop:

- It is a open source framework that is appropriate for processing large data sets on commodity hardware.
- It is the implementation of map-reduce and application programming model which is develop by google. This model provides two fundamental operations for data processing "Map & Reduce".

5. Force.com and Salesforce.com:

- Force.com is cloud computing platform at which user can develop social enterprise applications.
- The platform is the basis of salesforce.com software as a service (SaaS) solution for customer relationship management.
- Force.com allows creating applications by composing ready to use blocks a complete set of components supporting all the activities of enterprises which are available.

- From the design of data layout to the definition of business rules and user interface is provided by force.com as a support.
- This platform is completely hosted on the cloud and provides complete access to its functionalities and those implemented in the hosted applications through web service technologies.

6. Manjrasoft Aneka:

- It is one of the organization that works on cloud computing technology by developing software with distributed networks across multiple servers.
- create scalable customizable building blocks essential to cloud computing platforms build software to accelerate applications i.e, designed by for network multi-core computers
- Provide Quality of Service and service labelled agreement based on service level agreement which allows the scheduling, dispatching, praising of applications and accounting services businees or public computing network environment.
- Development of applications by enabling rapid generation of legacy and new applications using innovative, parallel and distributed models of programming
- Ability of organization to use computing resources, business to speed up or compute data execution intensive applications.

unit-II : Virtualization

Introduction:

Virtualization "abstract hardware that can share common resources with multiple workloads"

- The variety of work-loads co-located on virtualized hardware while maintaining complete insulation migrating freely to infrastructure and scaling when required.
- cloud virtualization makes server operating systems and storage devices for virtual platform. It enables to share single physical resource of instance or application with several users by providing multiple machines. It also administrates the work through the transformation, scalability, economics and efficiency of traditional computing.
- It also refers to as cloud based services and applications, the customer can maximize resources through virtualization and reduce the physical system needs.

Increased Performance and Computing Capacity:

A unique corporate data center is, in most instance, unable to complete in terms of security performance, speed and cost-effectiveness with network of data center provided by service provider. The majority of services available on demand in a short period of time, the user can also have large amount of computing resource with tremendous is and flexibility without any cost investment.

Under Utilized Hardware and Software Resources:

Hardware and software undergoes under utilization It is occured due to

- increasing performance and computing capacity
- Effect of limited resources to use.

If we consider IT infrastructure of an enterprise there are lot of computers that are partially

utilize while they could have been used without interruption using these resource for other purp after work hours to improve the efficiency of IT infrastructure. In order to provide transparency in services it would be necessary to deploy completely separate environment to which virtualization can be achieved.

Lack of Space:

The continuous need of additional capacity wh there is a storage and compute power and makes data center grow quickly. Google and Microsoft expand their infrastructure by buildi their datacenter as large as football fields. That are able to post thousands no. nodes. In most cases, enterprises cannot effort building another datacenter to accomodate additional resource capacity. This condition along with under utilization leads to the diffusion of server consolidation for virtualization technologies and fundamental.

Note: Server Consolidation it is a technique of aggregating multiple services & applications deployed on different server on one physical server. It allows to reduce the power consumption of datacenter and resolving hardware under utilization.

Greening Initiatives:

Data centers are one of the major power consumers and contribute consistently to the impact that a company has on that environment

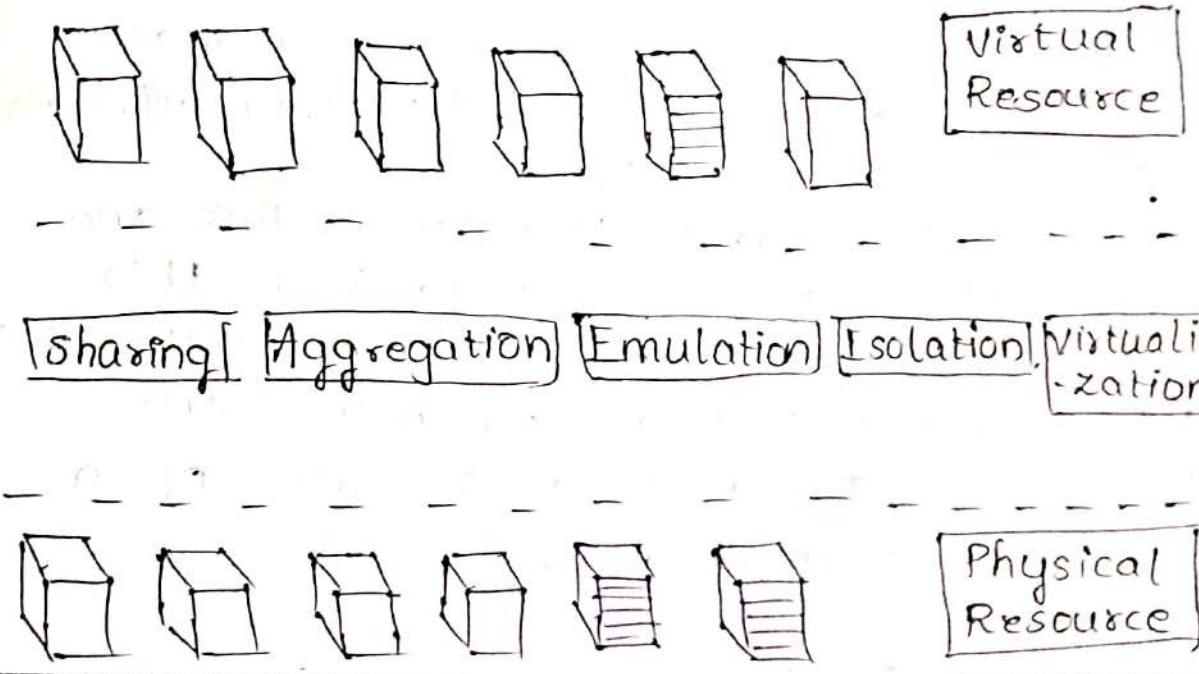
- Maintaining a datacenter operations does not only involve keeping severs on but also lot of energy is consumed for cooling
- Infrastructure for cooling has a significant impact on hard carbon footprint on datacenter

- Hence, reducing the no. of servers through server consolidation will definitely reduce the impact of cooling and power consumption of datacenters. It can provide effective way of consolidating servers.

Rise of Administrative Cost:

- Power consumption and cooling cost has become higher than the cost of infrastructu -re or equipment.
- Moreover the increase in demand for additional capacity which translates into more services or servers in a datacenter.
- It is also responsible for the significant incre -ment in the administrative cost.
- computers in particular servers donot operate on its own but they require care and feeding from system administrator.
- Common system administrator task includes hardware monitoring if into hardware replacement server setup and d updates server resources monitorings and backups.
- Virtualization can help in reducing the no. of required servers for given work load, reducing the cost of effective personals.

Characteristics of Virtualization:



1. Increased Security:

- The ability to control the execution of guest is completely transparent and opens new possibilities for delivering a secure controlled execution environment
- All guests programs operate usually against the virtual machine translating them and using them for host programs.
- A virtual machine manger can govern and filter guest program activities so as to prevent harmful operations being carried out.
- Resources exposed by the host can be hidden without the need of installing complex security policies.

2. Managed Execution:

Not only increased security virtualization can implement many features like sharing, Aggregation, Emulation, Isolation.

a) sharing:

- Virtualization makes it possible to create a separate computing environment in the same host
- This common function reduces the amount of active servers and reduce energy consumption

b) Aggregation:

- The physical resources can not only share between several guests but virtualization also enables the aggregation.
- A group of separate host can be link and represent as a single virtual host, this functionalities is implemented using the cluster management software which uses and represents the physical resource of a uniform group of machines.

c) Emulation:

- Guests are executed within the environment that are controlled by the virtualization layer which is ultimate program and entirely different environment can also be emulated with regard to the host, so that guest programs that require certain features not present in the physical host can be carried out.

d) Isolation:

- Virtualization allows guest provide an entirely separate environment in that they are executed.
- If they are OS's, applications or other entities The guest program operates through abstraction layer which provides access to underlaying resources.
- It is able to filter guest activities and prevent harmful operations against the host
- Performance tuning is another feature of virtualization. This feature is available a reality at present time given the considerable advances in hardware and software supporting virtualization
- By finely, tuning the properties of resources expose to the virtual environment has made it easier to control the performance of guest.
- Effective implementation of quality of services infrastructure fulfills service label agreement established for the host

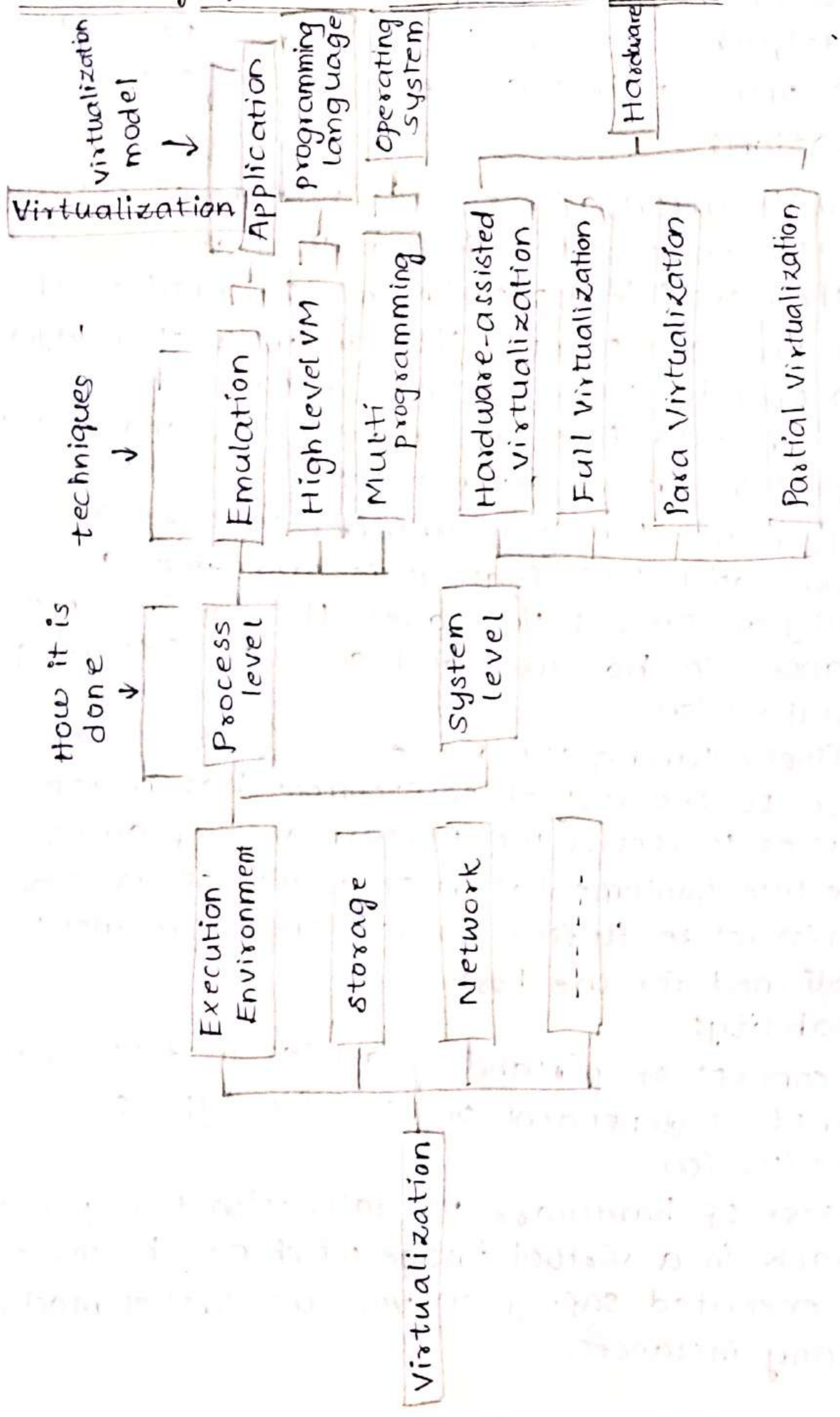
e) Portability:

- The concept of portability applies in different ways. It is dependent on specific type of virtualization
- In case of hardware virtualization the guest is pack in a virtual image which can be moved and executed safely on various virtual machines in many instances.

(iv) With the virtualization of the programming level as carried out in JVM or in .net runtime.

(v) The binary code of the application component may work on respective virtual machine without recompilation.

Taxanomy of virtualization techniques:



- Virtualization covers a wide range of Emulation techniques that are applied to different areas of computing.
- The service or entity is discriminated by first classification i.e, being emulated
- Virtualization is mainly used to emulate execution environment, storage and networking. Among these execution environment is the oldest and popular and most developed.
- This execution virtualization is categorized into two major categories considering the type of host they require.

i. Process level technique: are implemented in existing operating system with full hardware control.

ii. System level technique. These are carried out directly on hardware and require no support from existing operating system / require limited support. These two categories we can outline different methods providing post guest different virtual computing environment: bare hardware, operating system resources, low-level programming language and application libraries.

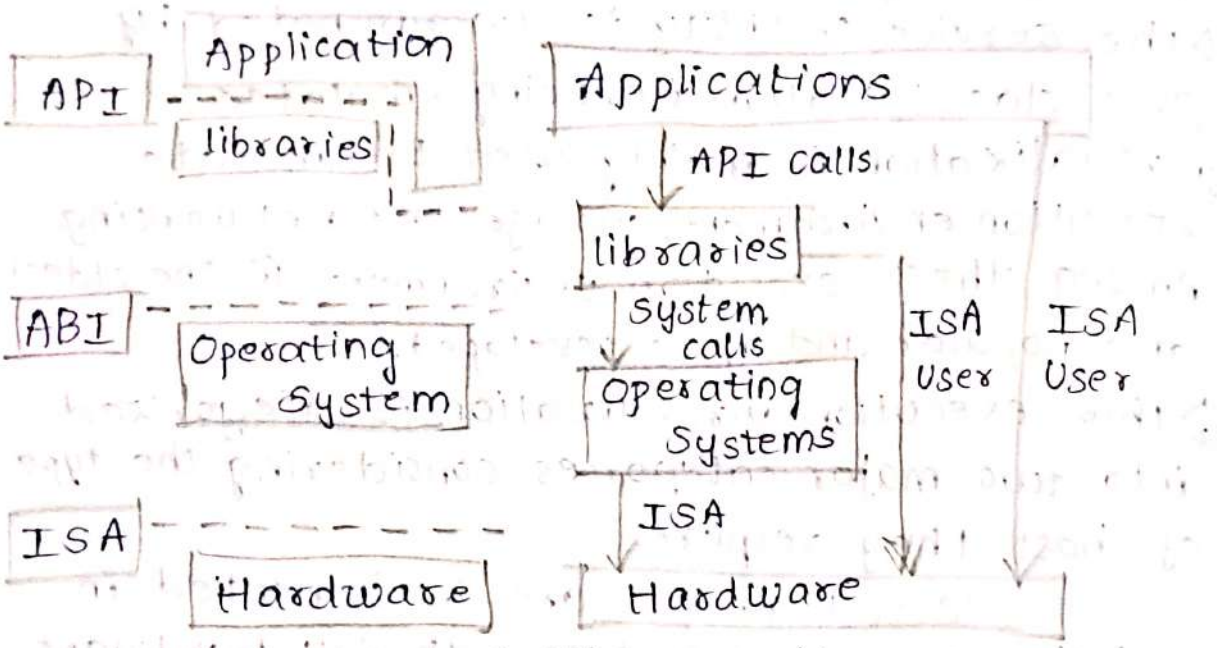
Execution Environment: Virtualization:

Execution virtualization includes all the virtualization techniques whos aim is to emulate an execution environment that are separate from hosting the virtualization layer.

- All these techniques are focused on supporting program execution compiled against the model or application of an abstract machine model with the operating system and binary program specification
- The operating systems, applications, libraries can directly or dynamically connect to the

application image on top of the hardware

Machine Reference Model:



Virtualizing an execution environment at different levels of computing stack requires a reference model that defines the interface between the levels of abstraction which hides implementation details. Virtualization techniques actually replace one layer and intercept the calls that are directed towards it. A clear separation ~~that are~~ between layers simplifies their implementation which only requires the emulation of the interface and proper interaction with the underlying layers.

- Modern computing system can be expressed in terms of reference model

ISA (Instruction Set Architecture)

It is the bottom layer, it is expressed for hardware which defines the instruction set for the processor register memory and interrupts management. It is an interface between hardware and software

- It is important for the OS developer and application developer.

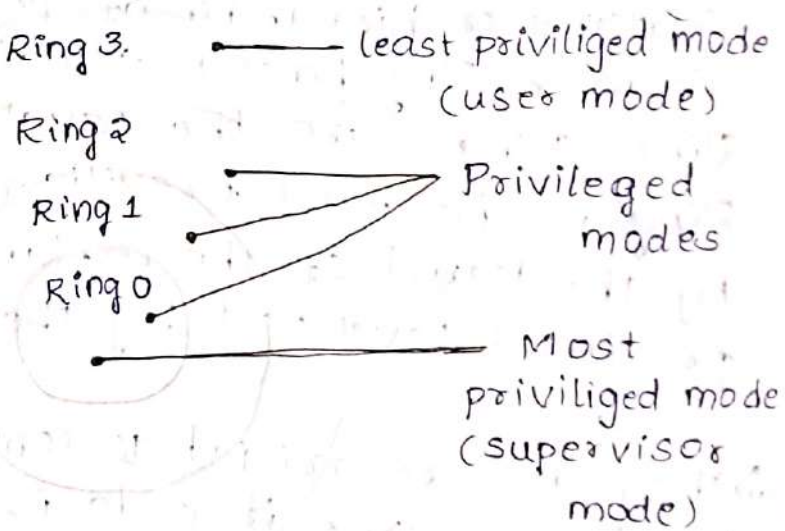
ABI (Application Binary Interface)

- It separates the operating system layer from applications and libraries. It is managed by OS
- ABI covers details such as low level datatypes alignment and fall conventions and defines a format of executable programs
- System calls are defined in this.

API (Application Program Interface)

- It is the highest level of abstraction, it is an interface between applications and libraries.
- API, ABI and ISA are responsible for making operations performed on application level
- High level abstraction is converted to machine level instructions to perform operations supported by the processor
- This layer approach simplifies the implementation of multitasking and co-existen-ce of multiple executing environment. It also provides a way for implementing a minimal security model for managing and accessing shared resources.

Security rings and Priviliged models:



The CPU operates mainly on two levels of previliges
1. Priviliged
2. Non-priviliged.

- The first distinguish can be made between priviliged and non-priviliged instructions are it defines on which mode the operations are performed.
- Non-priviliged instructions are those instructions that can be used without interfere with other task because they dont access share resources. This category contains all the fixed point, Heating and floating Arithemetic instructions
- Priviliged instructions are those that are executed under specific instructions restriction and are mostly used for sensitive operations which expose or modify the previliged state.
- Behaviour sensitive instructions are those that operates on the input/output. While control sensitive instructions older the state of CPU Registers
- Some types of architecture features more than one class of previliged instructions and implement those instructions are being accessed. For instance possible implementation features or hierarchy of previliges in the form of Ring based security. Ring 0, Ring 1, Ring 2, Ring 3 are the levels of previliges. Ring 1 is the most previliged level it is used by the kernel of the OS. Ring 3 is the least previliged level used by the User.

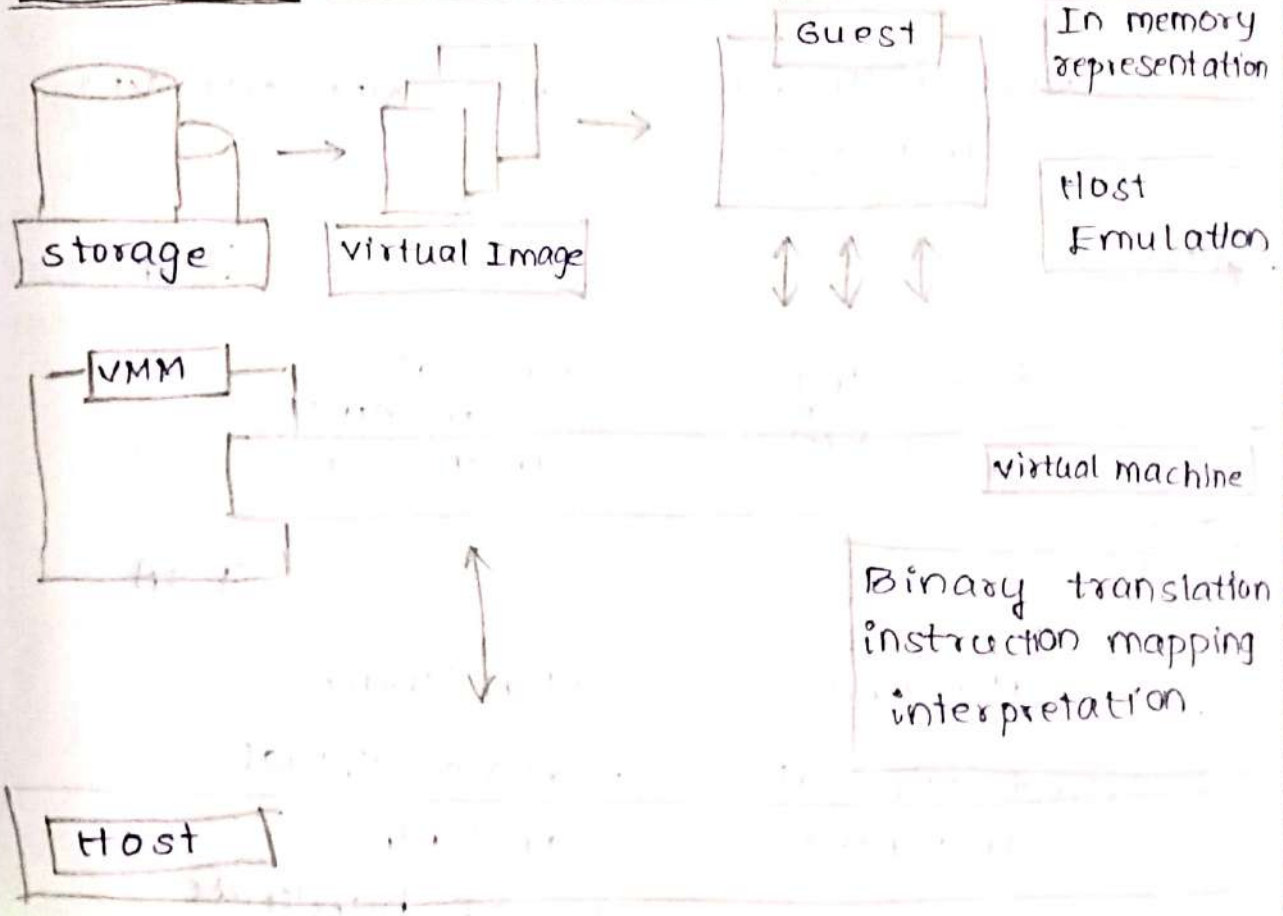
User mode:

- They are restricted to control the machine level resource if code is running in user mode. It invokes the previliged instructions hardware interrupts and trap the potentially harmful execution of the instructions.

Supervisor mode:

It is the master mode where all the instructions are executed without any restrictions. It performs sensitive operations on the hardware the difference between user and supervisor mode allows us to understand the role of Hypervisor. The hypervison runs above the supervisor mode. But in reality the hypervisor runs in supervisor mode and the division between priviliged and non-priviliged instructions. challenged in designing virtual machine manager.

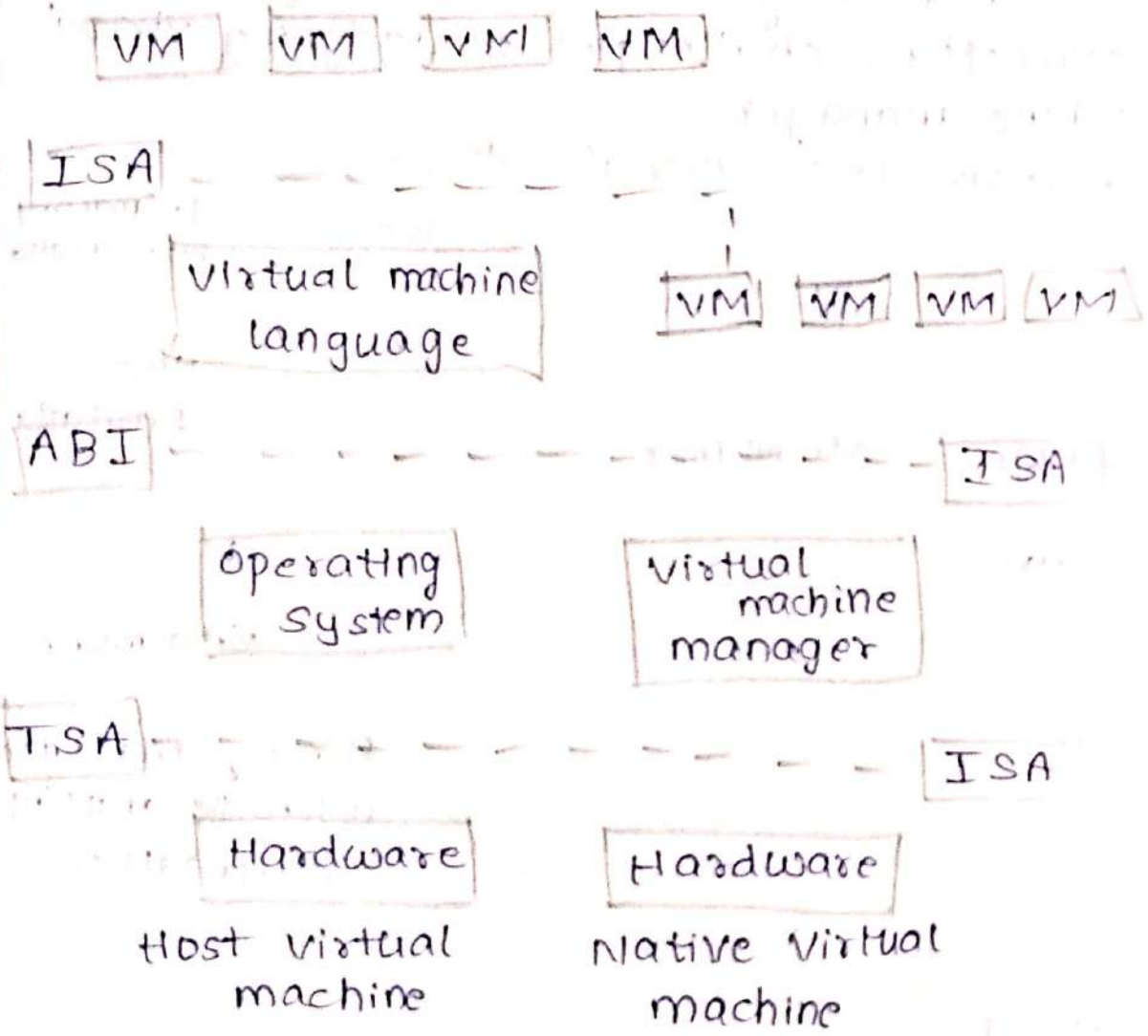
Hardware level Virtualization:



It is a virtualization technique ~~ar~~ that provides abstract execution environment in terms of computer hardware. On the top there is a Guest Operating system which can be run. The Guest represents the host by physical computer hardware. Virtual Machine by its emulation and the virtual machine manager by the

hypervisor. The combination of software and Hardware that allows the abstraction of underlying physical hardware is the general program of hypervisor. Hardware level virtualization is called system virtualization as it provides ISA to the virtual machine which represents the hardware interface of the system.

Hypervisor:



(v) Fundamental elements of hardware virtualization is the hypervisor or virtual machine manager (VMM). It recreates a hardware environment where guest operating systems are installed. There are two types of hypervisors. Type one,

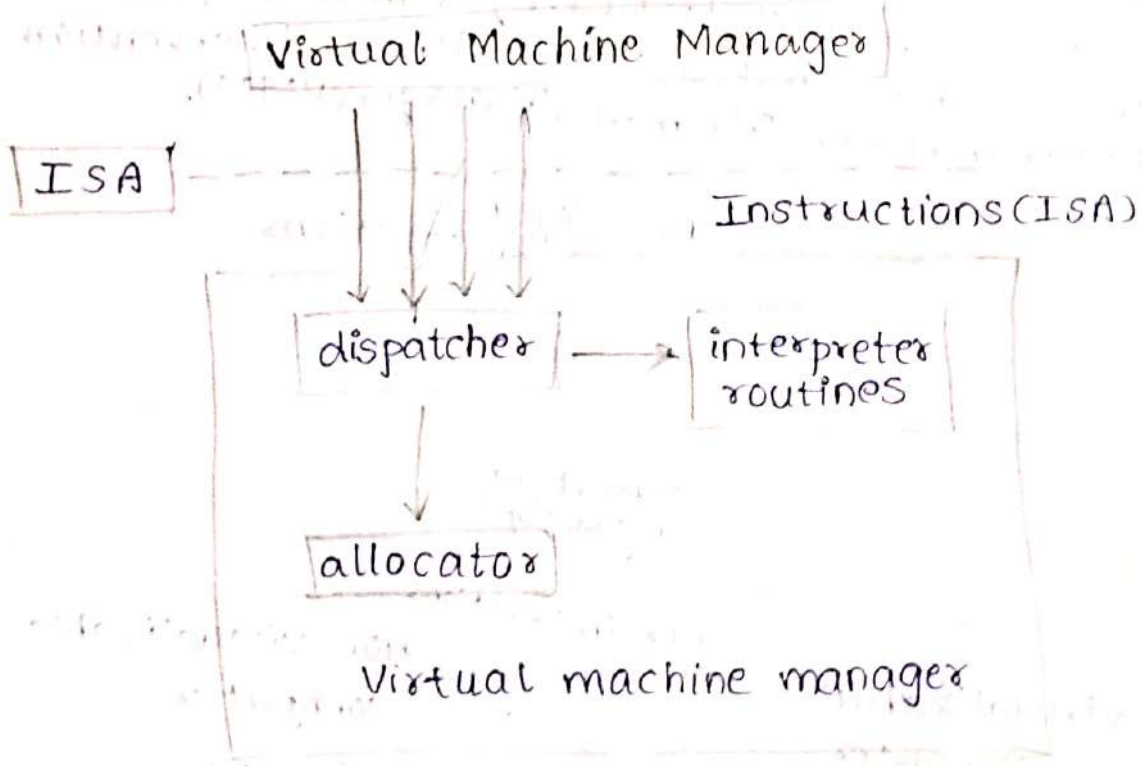
Type two.

Type One: It runs directly on the top of the hardware it interacts directly with the ISA interface exposed by the underlying hardware and emulate this interface in order to allow the management of guest OS. This type of hypervisor is called Native Virtual machine since it runs natively on hardware.

Type Two: This hypervisor require the support of an OS to provide virtualization services. This means that there are programs managed by operating system which interacts through ABI and emulate the ISA of virtual hardware for guest OS. This type of hypervisor is called Hosted virtual machine. since it is hosted within an OS

Hypervisor Reference Architecture:

The virtual machine manager is internally organized with 3 main modules. coordinates their activity in order to emulate the underlying hardware. They are dispatcher, allocator, interpreter.



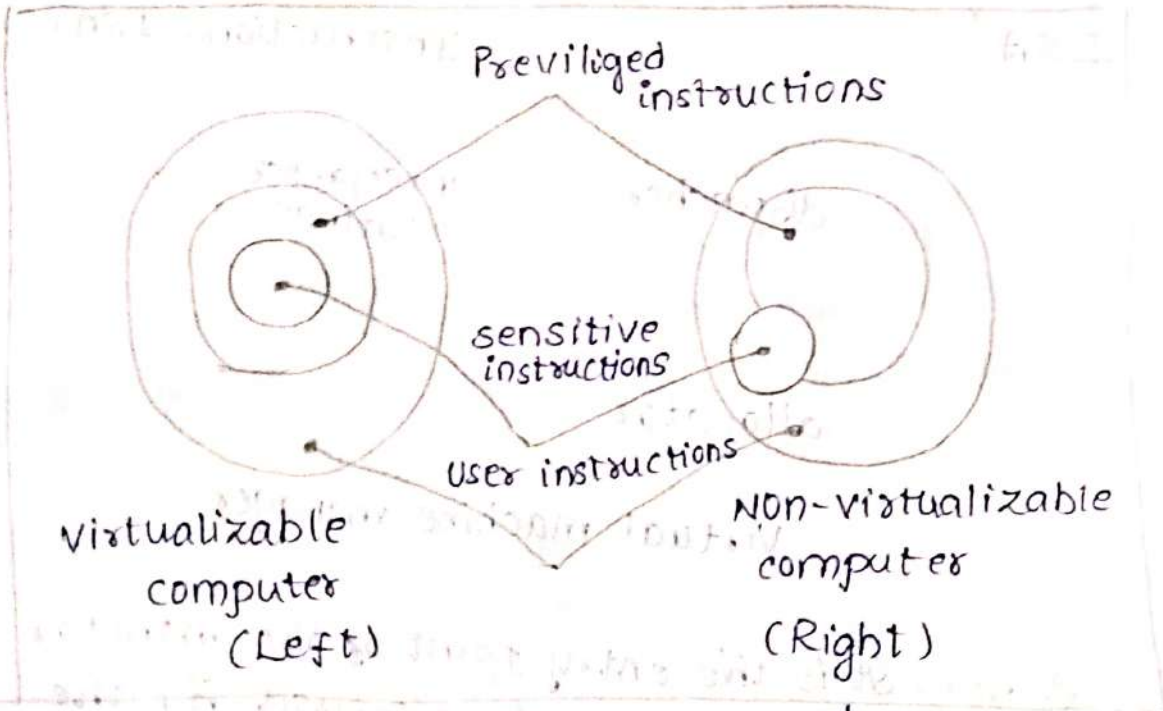
Dispatcher: It is the entry point of the monitor and re-routes the instructions issued by the Virtual Machine instance to one of the other two modules.

Allocator: It is responsible for deciding the system resources to be provided by the virtual Machine. Whenever the virtual machine tries to execute and instruction that results in changing the machine resources associated with virtual machine. The allocator is invoked by dispatcher.

Interpreter: Whenever virtual machine executes the previliged instructions a trap is triggered and the corresponding route is executed.

◊ The criteria that needs to be met by virtual Machine Manager to efficiently support virtualization were established by Goldberg & popek in 1974. The properties is to satisfy are :

1. Equivalence: The Guest running under the control of Virtual Machine Manager should exhibit the same behaviour as when executed directly on the physical host.
2. Resource Control: The virtual Machine Manager should be in complete control of virtualized resources.
3. Efficiency: A statistically dominant fraction of the machine instructions without intervention from virtual Machine Manager(VMM).



Theorem-1: For any conventional 3rd generation computers of VMM may be constructed, if the

set of sensitive instructions for that computer is the subset of previliged instructions.

Explanation:

All the instructions that change the configuration of the system resources should trap from the user mode and be executed under VMM

- This allows hypervisor to efficiently control only those instructions that could reveal the presence of an abstraction layer while executing all the rest of the instructions without considerable performance loss.

Theorem-2: A conventional 3rd generation computers is recursively virtualizable if.

i) it is virtualizable

ii) and VMM without timing dependencies can be constructed for it.

Explanation:

- Recursive virtualization is the ability of running a virtual machine manager on top of another VMM this allows nesting, hypervisor as long as the capacity of the underlying resources can accomodate them.
- Recursive virtualization of pre-requisite of hardware virtualization.

Theorem-3: A hybrid VMM may be constructed for any conventional 3rd generation machine in which the set of user sensitive instructions are a subset of set of priviliged instructions.

Explanation:

- There is another term called hybrid virtual machine (HVM) which is less efficient than the virtual machine system. In case of HVM more instructions are interpreted rather than being executed directly
- All instructions in virtual supervisor mode are interrupted whenever there is an attempt to execute a behaviour sensitive/control

sensitive instruction.

- HVM controls the execution directly or gains the control through trap. All the sensitive instructions are caught by HVM
- The reference model represents generally classic virtualization i.e, the ability to execute a guest operating system in complete isolation. To a greater extent hardware level virtualization includes several strategies that differentiate from each other-

→ which kind of support is expected from underlying hardware

→ what is actually abstracted from the host and whether the guest should be modified or not.

Hardware Virtualization Techniques:

1. Hardware Assistant Virtualization: This term refers to the hardware which provides architectural support for building a virtual machine manager which is able to run guest operating system in complete isolation.

◊ This technique was introduced by IBM System /370. The example of hardware assistant virtualization are the extensions to the X86-64 bit architecture introduced with Intel VT (formally known as Vander Pool) and AMD V (formally known as Pacifica)

◊ These extensions differ between two vanders that are meant to reduce performance penalities.

◊ Before the introduction of Hardware Assistant virtualization, Software Emulation of X86 hardware was significantly costly from the performance point of view. This is because it doesn't meet the formal requirements introduced by Popek & Goldberg

and easly products used binary translation in order to trap some sensitive instructions

- Products such as VMware virtuallization platform was introduced in 1999 which is based on x86 virtualization.

2. Full Virtualization:

- This refers to the ability of running a program most likely on operating systems on the top of virtual machine directly and without any modifications as if it where run on the ~~orfing~~ Raw hardware.
- In order to make it possible VMM are required to provide a complete isolation Emulation of the entire underlying hardware.
- The main advantage of full virtualization is complete isolation which leads to enhanced security
- The key challenge is the interception of previliged instructions such as IO instructions since they change the state of the resource exposed by the host which is contained within the VMM
- The simple solution to achieve full virtualization is to provide virtual environment for all the instructions so that some limits to the performance.
- A successful and efficient implementation of full virtuallization is obtained with the combination of hardware and software and not allowing the harmful instructions to be executed directly on the host

3. Partial Virtualization:

- It provides partial emulation of the underlying hardware thus not allowing the complete execution of the guest operating system in complete isolation.

- It allows many applications to run transparently but not all the features of the operating system can be supported as happened in full virtualization.
- Example of partial virtualization is address ~~base~~ space virtualization which is used in time sharing systems. This allows multiple applications and users to run concurrently in a separate memory space but they still share the same hardware resources.
- Hardware Partial Virtualization is the important mile stone for achieving full virtualization and it was implemented on IBM ~~x x 4 7 4~~ M44/44x
- Address ~~base~~ space virtualization is the common feature of contemporary operating system.

Para Virtualization:

- It is not transparent virtualization solution. Para virtualization techniques exposes a software interface to the virtual machine that is slightly modified from the host and as a consequence guest need to be modified.
- The main aim of para virtualization is to provide the capability to demand the execution of performance in critical operations directly on the host to prevent performance loss that is experienced in managed execution.
- It allows similar implementation of Virtual Machine Manager that had to transfer the execution of these operations which were hard to virtualize directly to the host.
- The technique has been successfully used for Xen for providing virtualization solution for Linux based operating system specific ~~codes~~ parts to run on Xen Hypervisor

- The solution is provided by Xen for running windows based operating system on x86 architecture. Other solutions using para virtualization includes VMware, parallels & some solutions for Embedded and real time environment such as TRANGO, Wind River and XtratuM

Other types of Virtualization:

1. Storage Virtualization:

- It is a system administration practice that allows decoupling the physical organization of the hardware from its logical representation
- By using this technique user donot have to worry about the specific location of their data which can be identified by the logical path
- It allows wide range of storage facility and represent them under the single logical file system
- These are different techniques for storage virtualization. one of the most popular includes network based virtualization by means of storage area network it uses a network accessible device through a large bandwidth connection that provide storage facility

2. Network Virtualization:

- It combines hardware appliances and specific software for the creation of management of a virtual network it can aggregate different physical networks to a single logical network or provide network like functionality to an operating system to a partition
- the result of external network virtualization is generally a virtual LAN. VLAN is an aggregation of host that communicate with each other as if they were located under

same broadcasting domain.

- Internal network virtualization is applied together with hardware and operating system level virtualization in which the guest obtain the virtual network interface to communicate with them
- there are several options for implementing internal network virtualization
  i. The guest can share the same network interface of the host
  ii. The VMM can emulate and install on host the guest can have a private network only with the guest.

3. Desktop Virtualization:

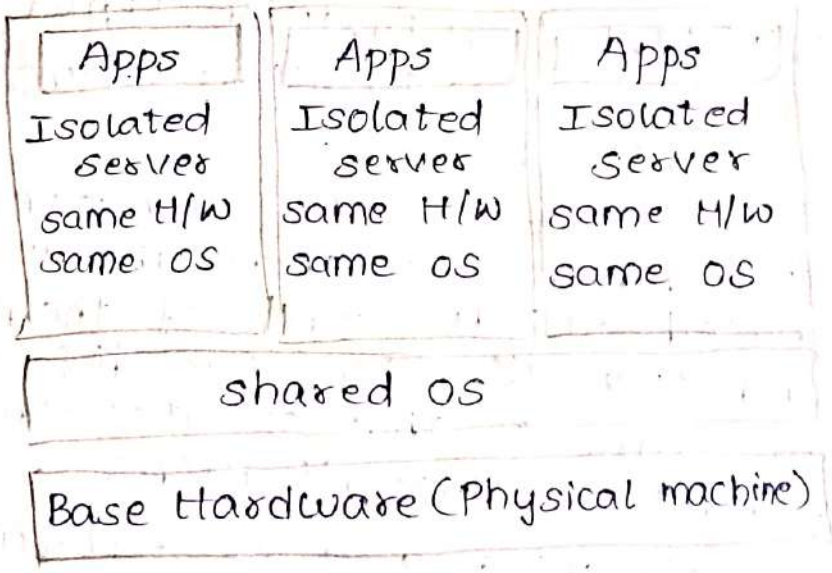
- It's an abstract the desktop environment is available on personal computer in order to provide access to it by using client-server approach
- It provides the same outcome of hardware virtualization but serves for different purpose.
- Desktop virtualization addresses the problem of making the same desktop environment accessible from everywhere.
- It strictly refers to the ability to remotely access a desktop environment. It is stored in remote server or datacenter which provides high availability, infrastructure and ensures the accessibility and the presistence of the data.
- The advantage of desktop virtualization are high availability, presistence, accessibility, and ease of management.
- The basic services for remotely accessing a desktop environment are implemented in software components such as windows remote services, VNC and X-servers

- Infrastructure for desktop virtualization is based on cloud computing solutions Sun Virtual Desktop Infrastructure (VDI), Parallels Virtual Desktop Infrastructure, Citrix XenDesktop and others

4. Application server Virtualization:

- It abstracts a collection of application servers that provides the same services as a single virtual application server by using load balancing strategies and providing a high availability infrastructure for the services hosted in a application server. This is the particular form of virtualization and serves the same purpose of storage virtualization providing a better quality of service rather than emulating a different environment

5. Operating System level Virtualization:



- It offers the opportunity to create different and separate execution environment for applications that are managed concurrently. It is different from hardware virtualization there is no VMM or hypervisor and the virtualiza-tion is done with the single OS where the OS kernel allows for multiple isolation and userspace instance.

- The kernel is responsible for sharing the system resources among instance and limiting the impact of instance on each other. OS supports this type of virtualization for general purpose time share OS with the capability to provide stronger name space and resource isolation.
- Virtualization technique is considered an evolution of chroot mechanism in UNIX system. This operation changes a file system directory for process and its children can't have access to other positions of the file system then those accessible under new root directory. By using this method in Unix system it is possible to complete isolation for a set of processors. By following this principle OS level virtualization aims to provide separate and multiple execution containers for running applications.
- Examples of OS level virtualization are free BSD Jails, IBM. Logical Partition (LPAR), solaris zones and containers, Parallels. virtuozzo containers, openVZ, icore, etc.
- These services offered by each other technologies and most of them are available on unix based system some of them solaris and open VZ allows for different versions of same OS that operates concurrently.

6. Programming level virtualization:

- This is mostly used area of deploying application managing execution and portability across different platforms and OS.
- It consists of virtual machine execution the byte code of a program which is the result of compilation process ...
- Compilers implemented used the technologies to produce a binary format representing the machine code of an abstract architecture.

- The byte code can be either interpreted or compiled on fly-jitled-against (Just in time) for underlying hardware instruction set.
- In the history programming level virtualization is used in 1986 for implementation of Basic combined programming language. BCPL. The language for writing compilers and one of the ancestors was C language. Some examples to use this technology are VCSP Pascal and Small talk.
- In 1996, VM programming language became popular with an introduction of Java, platform by sun. The JVM was originally designed for the execution of programs written in Java language. By other languages such as python, pascal, Ruby where available
- The ability to supporting multiple programming language has become the key element of common Language Infrastructure (CLI) which is significant behind .net framework. Currently Java platform and .Net represents most popular technologies both Java and CLI are stack based VM's
- The main advantage of programming level VM's are also called process virtual Machine. If is the ability of providing Uniform execution environment across different platforms.
- Implementation of this model also called high level VMS. Since high level programming languages are compile to a conceptual ISA which is further interpreted or dynamically translated against the specific instruction of the host platform.

7 Application-level virtualization:

- This level allows applications to be run on run-time environment which donot natively support all the features required by such application
- these applications are not installed in the expected run-time environment but run as if they were.
- This techniques are mostly concerned with partial file system libraries and operating systems components to emulate.
- Emulation is done by thin layer - a program, or a operating system components i.e, incharge of executing the applications
- Emulation can also be used to execute program libraries for different hardware architecture. It follows few strategies for implementation.

i.) Interpretation:- In this technique every source instruction is interpreted by emulator for executing native ISA instructions leading to over performance. Interpretation has minimal startup cost but a huge overhead since each instruction is emulated.

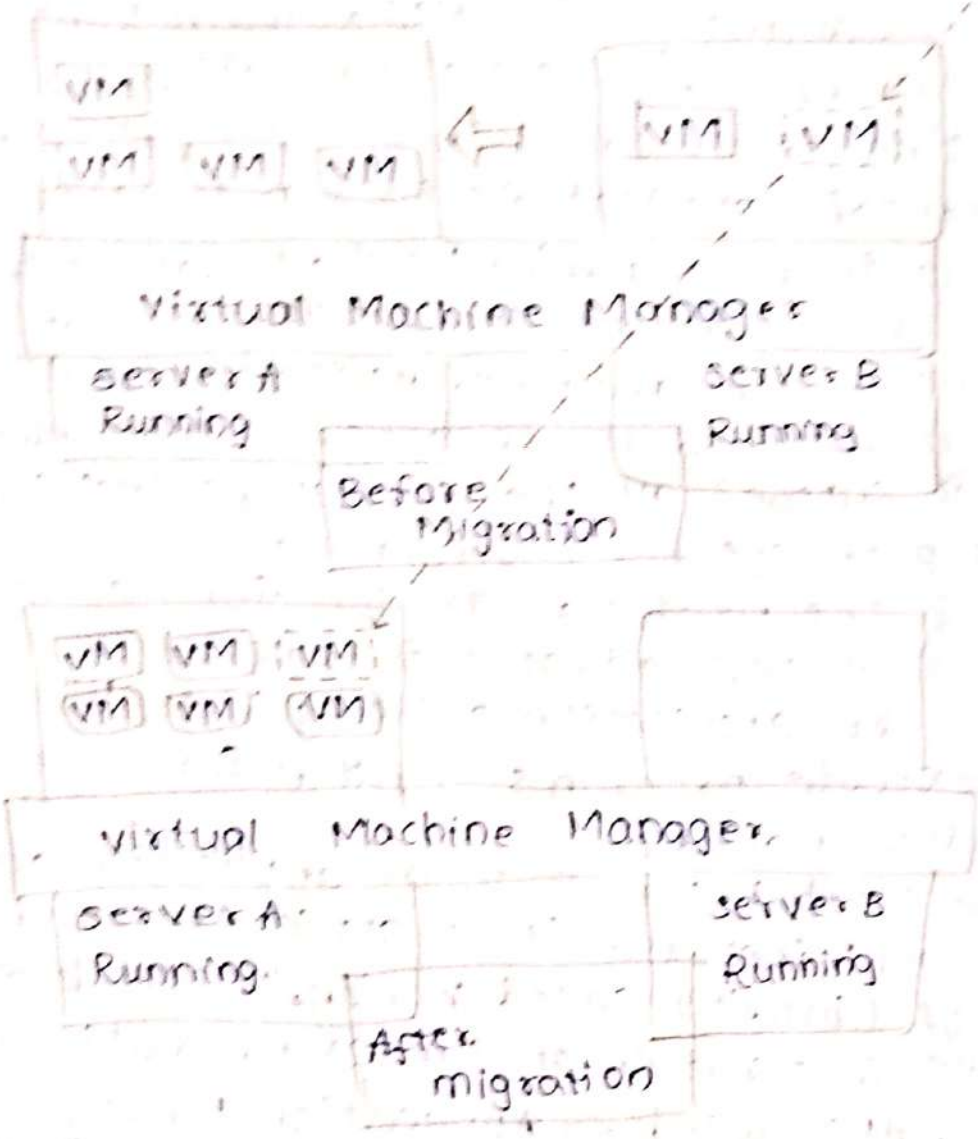
ii.) Binary Translation:- In this technique every source instruction is converted to native Instruction with equivalent functions After a block of instructions is translated it is cached and reused.
Binary Translation has a large initial over head cost but overtime it is subjected to a better performance. Since previous translated instructions are blocked and directly executed.

iii.) Application virtualization is a good sol^n in the case of missing libraries in the host operating system. In this case replacement libraries can be linked with the applications / library calls can be remapped

to existing-functions available in the host system.

- Another advantage is VMM is much lighter since it provides partial emulation on the Run-time environment. This technique allows incompatable applications to run together
- compile to programming level virtualization it works across all the applications develop for the virtual machine, application level virtualization works on specific environment and it supports all the applications that run on top of specific environment
- One of the most popular soln for implementing application virtualization is wine which is a software application allowing UNIX like OS to execute programs written for Microsoft windows platform
- Wine features A software application acting as a container for Guest applications and a set of libraries called winlib. It was developed to the inspiration of similar products from sun. WABI - Windows Application Binary Interface which implements the Win 16 API Specification solaris.
- The similar soln for Max OSx enviroment is cross over which allows running windows application directly on Mac Osx operating System
- VMware ThinApp which allows the capturing setup of an installed Application and packing it into an executable image isolated from the Hosting operating System.

Virtualization and Cloud Computing



- Virtualization plays a major role in cloud computing since it provides costumization, security, isolation and manageability. These are fundamentals of IT services.
- Virtualization technologies primarily used to offer configurable computing environment and storage.
- Network virtualization is less popular in most of the cases it is the complementary feature to build virtual computing system.
- Virtual computing environment and execution virtualization techniques plays a prominent role
- Hardware virtualization is the enabling factor for solutions in the infrastructure as a service for market segments

- Programming language virtualization is a technique for leveraging platform as a service
- Virtualization also allows isolation and the final control that specifies leasing of services and their accountability
- It gives an opportunity of designing more effecient computing systems by means of consolidation which is performed transparently in cloud computing.
- If they are underlying resources there will be no evidence of such sharing. The opportunity is particularly attractive when the resources are under utilization because it allows reducing the no. of active resources by aggregating virtual machines over small no. of resources that it comes to fully utilized. This is known as server consolidation. The moment between virtual machines instances is called virtual machine migration.
- By temporarily stopping its execution and moving the data to the new resources are by performing final control and moving the instance while it is running. This technique is called Live Migration.
- Server consolidation and virtual Machine Migration are the principles of Hardware virtualization. Even though it is technically possible in case of programming language virtualization
- Storage Virtualization consists opportunity given by virtualization techniques as it is complementary for execution Virtualization.
- Cloud computing is the concept of desktop virtualization which is initially introduced

by Mainframes era. It is the ability to create the entire computing stack from infrastructure to application services on demand that opens the path to having complete virtual computer hosted on the infrastructure of the provider and accessed by thin client over a capable internet connection.

Pro's and Con's of Virtualization:

- Virtualization in cloud computing offers significant benefits such as efficient use of resources easier recovery improves scalability but it also introduces challenges like performance, complexity and security

Advantages:

1. Effective resource utilization- It lets multiple virtual machines run on a single physical server reducing hardware wastage and operating cost.
2. High Availability and Recovery- cloud environment uses virtualization tools for rapid data backup duplication and recovery minimizing down time and data loss.
3. Scalability and Flexibility- Deploying and scaling virtual servers is quick and easy resources are released based on demand supporting dynamic business needs.
4. Energy and cost-saving- Fewer physical machines translate into low power usage and cooling demands, cutting energy costs and reducing environment impact
5. Isolation and Security- Isolation environment for testing, development and production
6. Centralised Management- Manages many virtual instances for a single interface making operations more streamline

Disadvantages

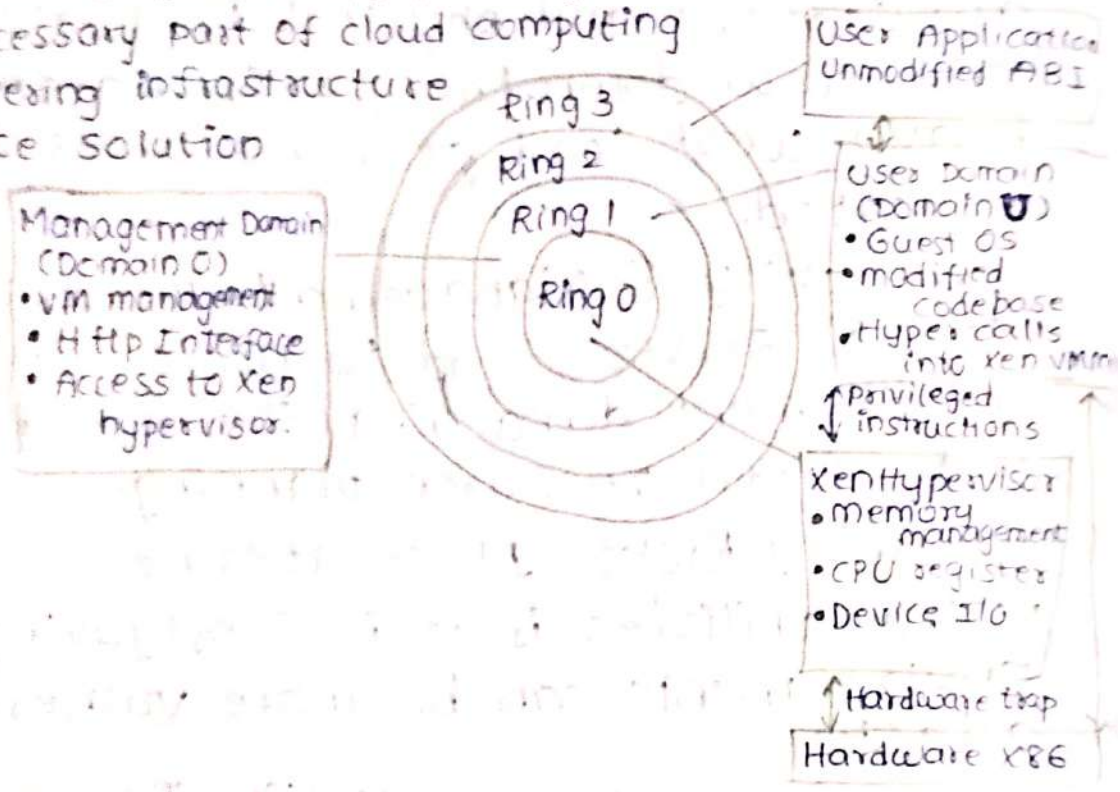
1. High Initial Investment - setting up a virtual infrastructure requires investment in hard-ware, software licenses, technical trainings which can be expensive especially for smaller organizations.
2. Performance - It adds layers between applications and physical hardware which can slow down the performance under heavy work load or if resources are over allocated.
3. Complexity & Management - The increased no of virtual servers lead to more complex environment demanding specialized IT skills and careful resource planning.
4. Security Risks - It creates new security vulnerabilities if it is configuring properly environments can be more vulnerable for attacks.
5. Licensing and compactibility Issues - Software licensing for virtual machines can be complex and not all appli eations supports virtualization
6. Server Sprawl - Rapid creation of new virtual servers can lead to server sprawl.

Technology Examples:

Xen Para Virtualization:

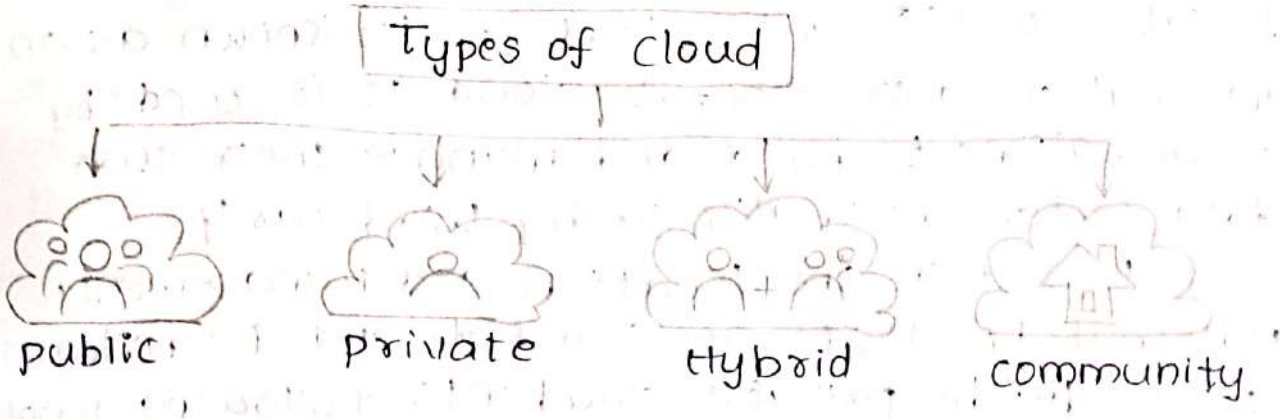
xen is an opensource hypervisor based on Para virtualization It is the most popular application of Para virtualization xen has been extended to compatible with Full virtualizati-on using hardware assistant virtualization. It enables high performance to execute guest operating systems. This is postablely done by removing the performance loss while executing the instructions requiring significant handling by modifying position of the guest os executed by xen. with reference to the execution of such instructions. This especially supports x86 which is the most used architecture on commodity machines and servers. xen architecture and its mapping onto a x86 previliged model is described in the below diagram. xen base systems is handled by xen hypervisor which is executed in the most

previleged mode and maintains the access of guest OS to the basic hardware. Guest OS runs between the domains which represent virtual machine instances. Particular control software has previleged access to the host and handles all other guest OS runs the special domain called domain 0 This is the only one loaded once. the virtual machine has been fully booted and hosted on http server that delivers request to virtual machine creation, configuration & termination This component establishes the primary version of shore VMM which is necessary part of cloud computing system delivering infrastructure as a service solution

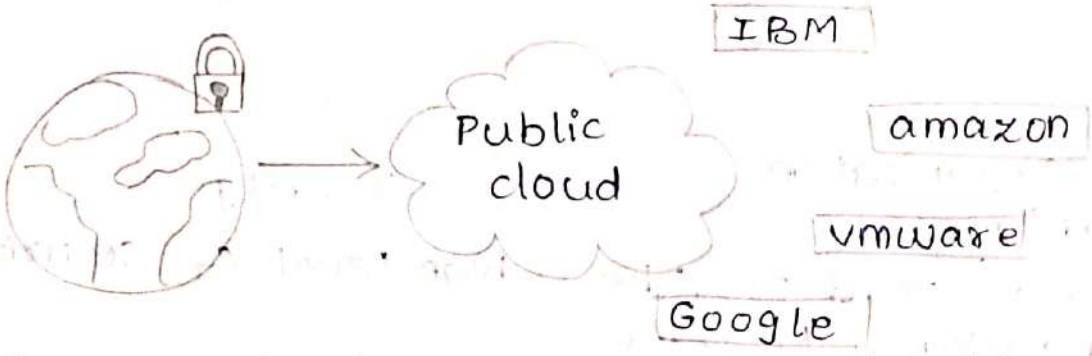


Unit-3

Types of cloud: There are the following 4 types of cloud that you can deploy according to the organization's requirements.



Public cloud - Public cloud is open to all to store and access information through internet using the pay-per-usage method. In public cloud, computing resources are managed and operated by cloud service Provider (CSP).



Ex: Amazon Elastic ~~clou~~ compute cloud (EC2), IBM smart cloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.

Advantages:

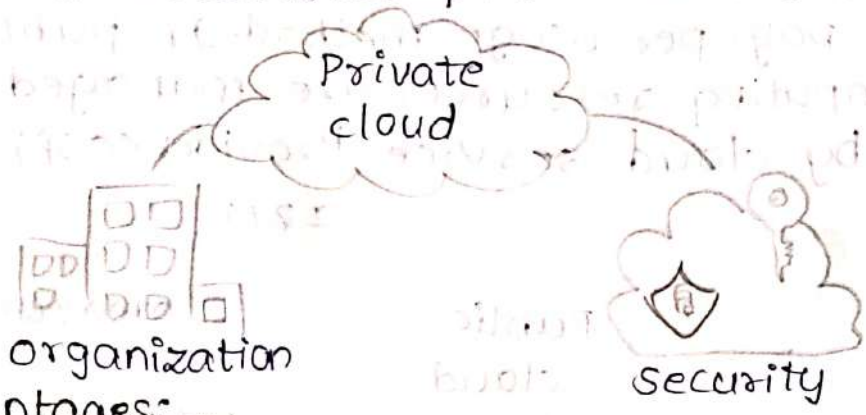
- Public cloud is owned at a lower cost than the private and hybrid cloud.
- Public cloud is maintained by CSP. so do not need to worry about the maintainence.
- Public cloud is easier to integrate. Hence it offers a better flexibility approach to consumers.
- Public cloud is location independent because its services are delivered through the internet.

Disadvantages:

- Public cloud is less secure because resources are shared publicly.
- Performance depends upon the high speed internet network link to the cloud provider.
- The client has no control of data.

Private cloud: Private cloud is also known as an internal cloud or corporate cloud. It is used by organizations to build and manage their own data centers internally or by third party

Based on the location and management, National Institute of Standards and Technology (NIST) divide private cloud into following two parts. i. on-premise private cloud
ii. outsourced private cloud.



Advantages:

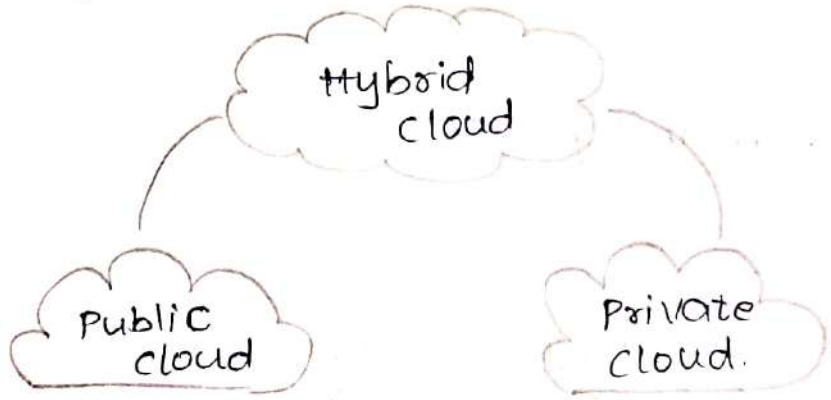
- Private cloud provides a high level of security and privacy to users.
- Private cloud offers better performance with improved speed and space capacity.
- It allows the IT team to quickly allocate and deliver on-demand IT resources.
- The organization has full control over the cloud ~~base~~ because it is managed by the organization itself. so there is no need for organization to depends on anybody.
- It is suitable for organizations that require a separate cloud for their personal use and data security is the first priority.

Disadvantages:

- skilled people are required to manage and operate cloud services.
- Private cloud is accessible within the organization so the area of operations is limited
- Private cloud is not suitable for organizations that have a higher user base and organizations that donot have the pre-built infrastructure, sufficient manpower to maintain and manage the cloud.

Hybrid cloud: Hybrid cloud is a combination of public cloud and private cloud. It is partially secure because the services which are running on the public cloud can be accessed by anyone, while the services are running on a private cloud can be accessed by the organization's users.

Ex: Google Application Suite (GMail, Google Apps and Google Drive), Office 365, AWS.



Advantages:

- Hybrid cloud is suitable for organizations that require more security than the public cloud.
- Hybrid cloud helps you to deliver new products and services more quickly
- Hybrid cloud provides an excellent way to reduce the risk.
- Hybrid cloud offers flexible resources

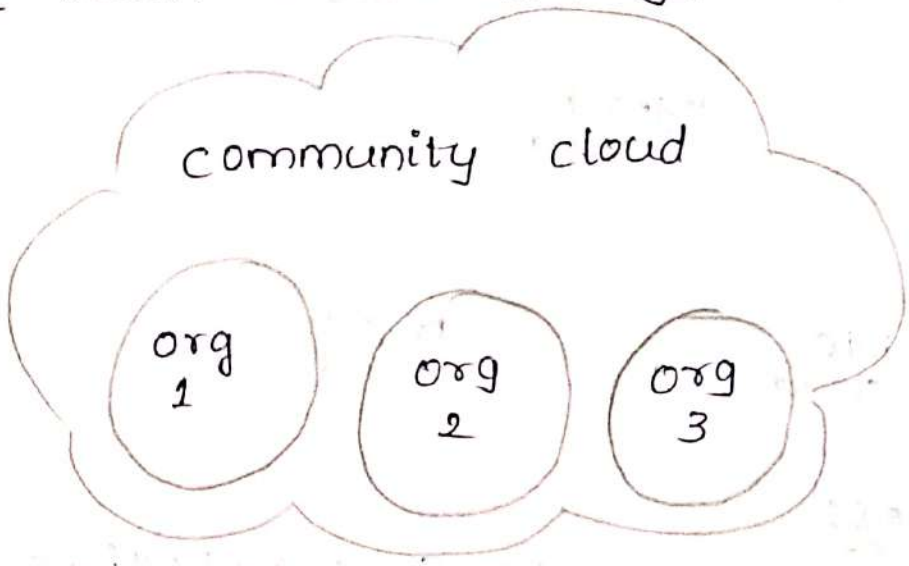
because of the public cloud and secure resources because of private cloud.

Disadvantages:

- In Hybrid cloud, security feature is not as good as private cloud.
- Managing a hybrid cloud is complex because it is difficult to manage more than one type of deployment model.
- In the hybrid cloud, the reliability of servic depends on cloud service Provider.

Community Cloud: Community cloud allows systems and services to be accessible by a group of several organizations to share the information between the organization and a specific community. It is owned, managed and operated by one or more organizations in the community, a third party or a combination of them.

Ex: Health care community cloud.



Advantages:

- community cloud is cost effective because the whole cloud is being shared by several organizations or communities.
- community cloud is suitable for organizations that want to have a collaborative cloud with more.

- Security features than the public cloud.
- It provides better security than public cloud.
- It provides collaborative and distributive environment
- Community cloud allows us to share cloud resources, infrastructure and other capabilities among various organizations.

Disadvantages:

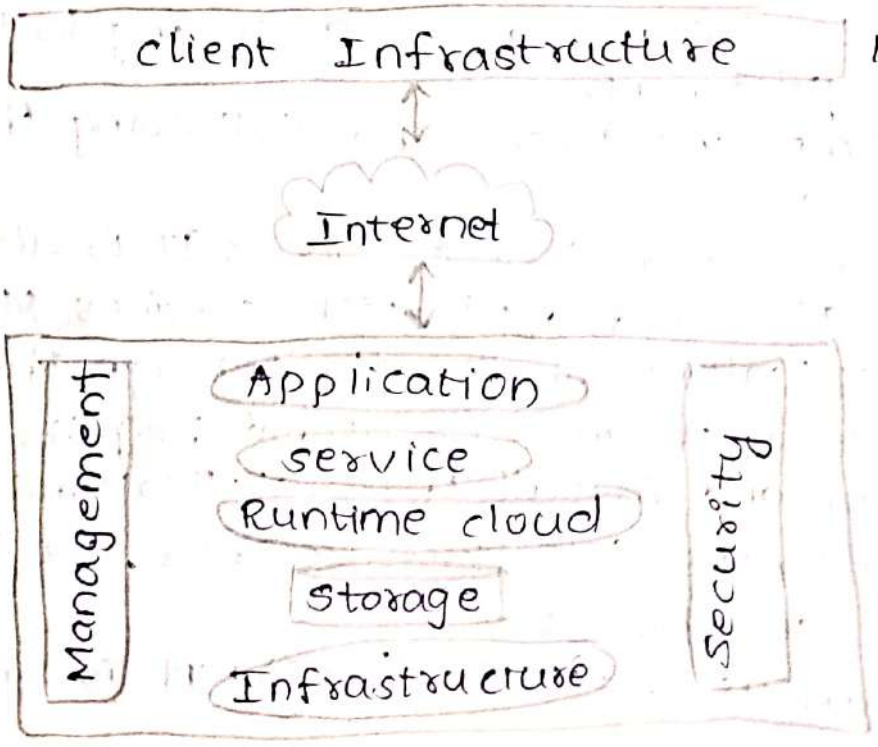
- Community cloud is not a good choice for every organization.
- Security features are not as good as private cloud.
- It is not suitable if there is no collaboration.
- The fixed amount of data storage and bandwidth is shared among all community members.

Cloud Computing Architecture

Cloud computing architecture is a combination of service-oriented architecture and event driven architecture. cloud computing architecture is divided into following two parts.

- Frontend
- Backend

The below diagram shows the architecture of cloud computing.



Frontend

The frontend is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The frontend includes web browsers (including chrome, Firefox, Internet Explorer, etc) thin and fat clients, tablets and mobile devices.

Backend

The backend is used by the service Provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.

Components of cloud computing Architecture:

These are the following components of cloud computing architecture

1. client Infrastructure - client infrastructure is a front end component. It provides GUI to interact with the cloud.
2. Application - The application may be any software or platform that a client wants to access.
3. service - A cloud services manages that which type of service you access according to the client's requirement.

   cloud computing offers the following three types of services.

   i. Software as a Service (SaaS): It is also known as cloud application services. Mostly SaaS applications run directly through the web browser means we do not require to download and install these applications.

   Ex: Google Apps, Salesforce Dropbox, slack, Hubspot, cisco WebEx.

   ii. Platform as a Service (PaaS): It is also

known as cloud platform services. It is quite similar to SaaS, we can access software but the difference is that PaaS provides a platform for software creation, but using SaaS we can access the software over the internet without the need of any platform
Ex: Windows Azure, Force.com, Magneto Commerce cloud, Openshift

iii. Infrastructure as a Service (IaaS): It is also known as cloud infrastructure services. It is responsible for managing applications data, middleware and run-time environments.
Ex: AWS, EC2, Google Compute Engine (GCE), cisco Metapod.

4. Runtime cloud - Runtime cloud provides the execution and runtime environment to the virtual machines.

5. Storage: Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage the data.

6. Infrastructure - It provides services on the host level, application level and network level cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software and other storage resources that are needed to support the cloud computing model.

7. Management - Management is used to manage components such as application, service, runtime cloud, storage, infrastructure and other security issues in the backend and establish coordination between them.

8. Security - Security is an in-built backend component of cloud computing. It implements a security mechanism in the backend.

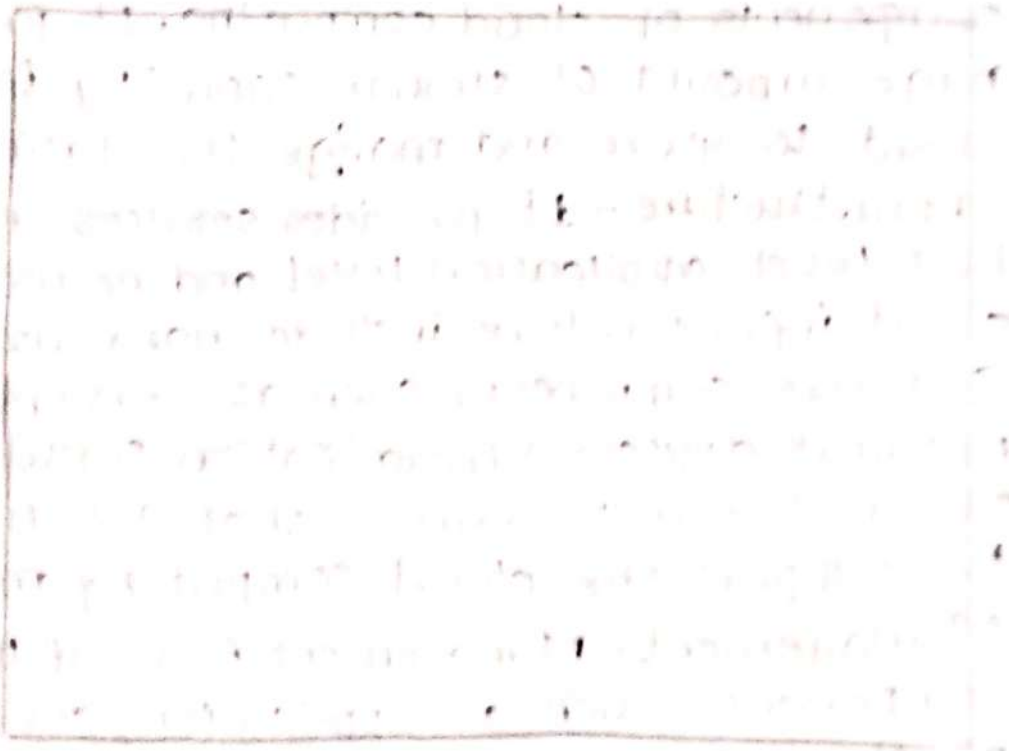
9. Internet - the Internet is medium through which frontend and backend can interact and communicate with each other.

Infrastructure as a Service (IaaS):

IaaS provides access to fundamental resources such as physical machines, virtual machines, virtual storage etc. Apart from these resources the IaaS also offers:

- Virtual machine disk storage
- Virtual LAN
- 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: IaaS allows the cloud provider to freely locate the infrastructure over the Internet in a cost-effective manner. Some of the key benefits of IaaS are listed below.

- Full control over computing resources - IaaS allows the customer to access computin

resources using administrative rights from virtual machines in the following manner

- Flexible and efficient renting of computer hardware IaaS resources such as virtual machines, storage devices, IP addresses, firewalls, etc are made available to the customers on rent. Also with administrative access to virtual machines, the customer can run any type of software.
- Portability, Interoperability - It is possible to switch between application and resources b/w IaaS clouds. For example, network applications such as web server or e-mail server that normally runs on customer owned server hardware can also run from VMs in IaaS cloud.

Issues: The various Issues of IaaS are

- Compatability with legacy security vulnerabilities Because IaaS offers the customer to run legacy software in provider's infrastructure, it exposes customers to all of the security vulnerabilities.
- Virtual Machine Sprawl - the VM can become out of date with respect to security updates because IaaS allows the customer to operate the virtual machines in running, suspended and off state. However, the provider can automatically update such VMs but this mechanism is hard and complex.
- Robustness of VM-level isolation - IaaS offers an isolated environment to individual customers through hypervisor. Hypervisor is a software layer that includes hardware support for virtualization to split a physical computer into multiple virtual machines.
- Data erase practices - The customer uses virtual machines that in turn use the common disk resources provided by the cloud provider. When the customer releases the resource, the cloud provide must ensure that next customer

to rent the resource are ...
residue from previous customer.

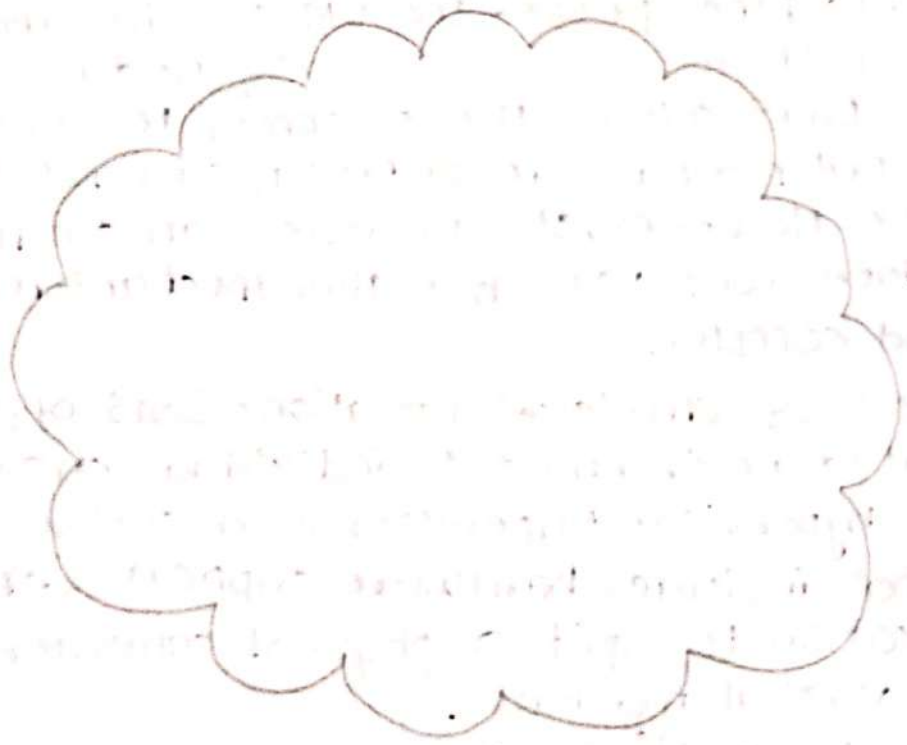
Characteristics

Here are the characteristics of IaaS service model:

- virtual machines with pre-installed software
- virtual machines with pre-installed OS such as windows, Linux and solaris
- On-demand availability of resources.
- Allows to store copies of particular data at different locations.
- The computing resources can be easily scaled up and down.

Platform as a Service (PaaS):

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



App engine of Google and Force.com are examples of PaaS offering vendors. Developer may log on to these websites and use the built-in API to create web based applications.

Benefits:

Following are the benefits of PaaS model:

- Lower administrative overhead - customer need not bother about the administration because it is the responsibility of cloud Provider
- Lower total cost of ownership - customer need not purchase expensive hardware, servers, power and data storage.
- Scalable solutions - It is very easy to scale the resources up or down automatically based on their demand
- More current system software - It is the responsibility of the cloud provider to maintain software versions and patch installations.

Issues:

Paas has significant Burdens on customer's browsers to maintain reliable and secure connections to the provider's system. However, there are some specific issues associated with PaaS are

- Lack of portability between PaaS Clouds: Although standard languages are used, yet the implementation of platform services may vary. For example, file, queue or hash table interfaces of one platform may differ from another, making it difficult to transfer the workloads from one platform to another
- Event based processor scheduling - The PaaS applications are event-oriented i.e, they have to answer a request in a given interval of time.
- Security engineering of PaaS application - since PaaS applications are dependent on network, they must have to use cryptography and manage security exposures.

Characteristics:

Here are the characteristics of PaaS service model.

- PaaS offers browser based development environment. It allows the developer to create database and edit the application code either via Application programming interface or point-and-click tools.
- PaaS provides built-in security, scalability and web service interfaces.
- PaaS provides built-in tools for defining workflow, approval processes and business rules.
- It is easy to integrate PaaS with other application on the same platform
- PaaS also provide web service interfaces that allow us to connect the application outside the platform.

Software as a Service (SaaS):

Software as a service model allows to provide software application as a service to the end users. It refers to a software that is deployed on a host service and is accessible via Internet. There are several SaaS applications listed below.

- Billing and invoicing system
- Customer Relationship Management applications
- Help desk applications
- Human Resource (HR) solutions

Characteristics:

Here are the characteristics of SaaS model

- SaaS makes the software available over the Internet.
- The software applications are maintained by the vendor
- The license 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 maintainence at end user side
- They are available on demand.
- They can be scaled up or down on demand.
- They are automatically upgraded and updated.
- SaaS offers shared data model. Therefore, multiple users can share single instance of infrastructure, it is not required to hard core the functionality for individual users
- All users run the same version of software.

Benefits: