

## \* Cloud Computing

Cloud Computing is on-demand availability of computer system resources (especially data storage / cloud storage & computing power) without direct active management by user.

Cloud Computing can be defined as delivering computing power (CPU, RAM, Network speeds, storage & software) a service over a network (usually on internet) rather than physically having computing resources at customer location.

In simple terms, it means storing, managing, accessing the data & programs on remote servers that are hosted on internet instead of computer hard drive.

## \* Characteristics of Cloud Computing :-

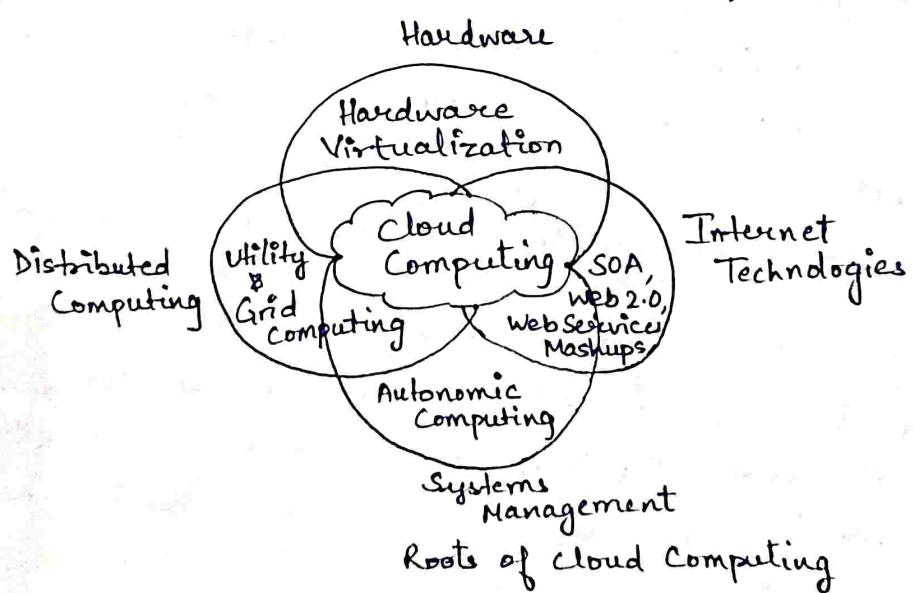
Some characteristics are as follows:-

- i) On-Demand Self Service → cloud computing resources can be provisioned on-demand by users, without requiring interactions with cloud service provider.  
The process of providing resources is automated.
- ii) Broad Network Access → Access to resources in cloud is available over the network
- iii) Resource Pooling → The computing and storage resources are pooled to serve multiple users using multi-tenancy.
- iv) Measured Service → cloud computing resources are provided to users on a pay per use model.  
The use of cloud system resources is measured, audited and reported to customer based on metered system.
- v) Performance → It provides improved performance for applications since the resources available to applications can be scaled up or down based on dynamic application workloads.

- vi) Ease of Utilization → Depending on type of service being offered you may find that you don't require hardware & software licences to implement your service.
- vii) Reliability → Applications developed in cloud computing environments generally have a higher reliability. Cloud service providers specify and guarantee reliability & availability levels for their cloud resources.
- viii) Reduce Cost → cloud computing provides cost benefits for applications as only as much computing and storage resources as required can be provided dynamically, and upfront investment in purchase of computing assets to cover worst case requirements is avoided. This saves significant cost for organisations & individuals.

### Roots of Cloud Computing →

The roots of cloud computing are connected to make a cloud computing infrastructure for enterprise.

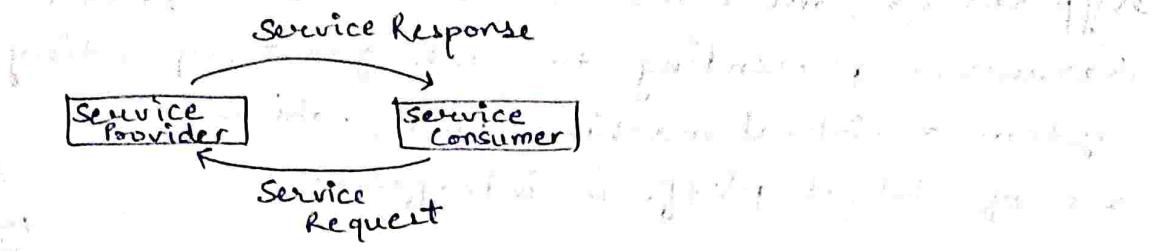


### 1) Internet Technologies:-

Internet technologies are widely accessible to public. People can access the content of our applications that depend on network connection.

Service oriented Architecture (SOA) allows to use application as a service for other application.

SOA allows to exchange of data between various applications.



Advantages:-

- i) Service Reusability
- ii) Easy Maintenance
- iii) Platform independent.
- iv) Reliability
- v) Scalability

In SOA software resources are packaged as service which is well defined self contained modules that provide by business functionality.

web information & services may be programmatically aggregated acting as a building blocks of complex compositions called service mashups.

## 2) Hardware Virtualization

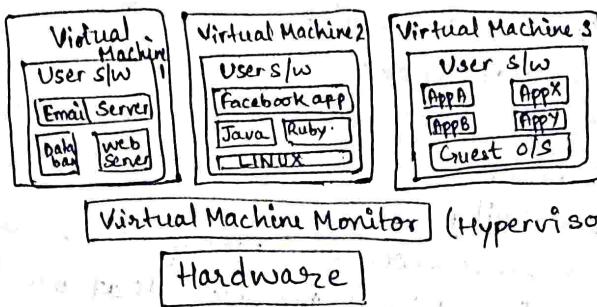
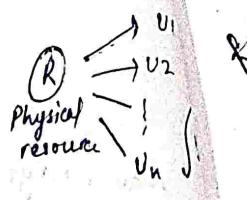
Hardware virtualization can be considered as a perfect fit to overcome most operational issues of data center building and maintenance.

The idea of virtualizing a computer system's resource, including processors, memory, and I/O devices, has been well established for decades, aiming at improving sharing and utilization of computer systems.

Hardware virtualization allows running multiple operating system & software stacks on a single physical platform.

Virtualization is a technique, which allows to share a single physical instance of resource or an application among multiple customers and organisations.

The virtual Machine Monitor (VMM), also called hypervisor, mediates access to the physical hardware presenting to each guest operating system a virtual machine (VM), which is a set of virtual platform interfaces.



### 3) Distributed Computing :-

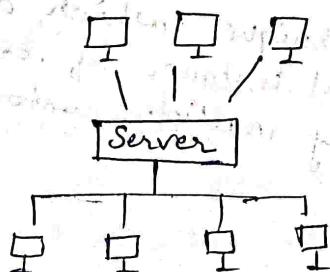
Utility Computing is a service provisioning model in which a service provider makes computing resources and infrastructure management available to customer as needed.

Utility is packaging of system resources, such as computation, storage and services as a metered service.

This model has the advantage of a low or no initial cost to acquire computer resources instead resources are essentially rented. In short terms, it is pay-per-use model and resources are allowed to use on-demand as metered service.

Grid computing facilitates aggregation of distributed resources and transparently accesses them.

Distributed Computing is which a group of computers from multiple locations are connected with each other.



## Automatic / Autonomic Computing :-

Autonomic or self-managing system rely on monitoring probes and sensors, on adaption engine for computing optimization based on monitoring data, and on effectors to carry out changes on system.

Four important characteristics of automatic system such as,

- i) self-configuration.
- ii) self-optimization.
- iii) self-healing
- iv) self-protection

## \* Cloud Architecture

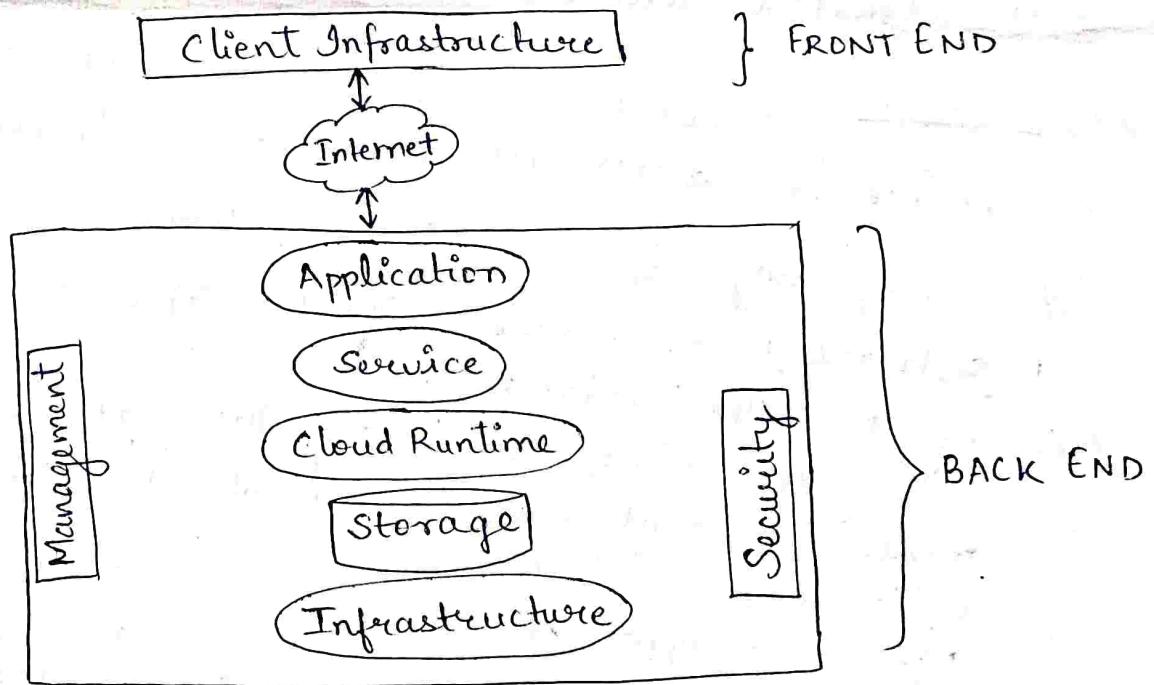
Cloud computing architecture is a combination of service-oriented architecture & event driven architecture.

Cloud computing architecture is divided into following two parts:

Cloud Computing architecture is divided into following two parts:

i) Front End

ii) Back End



### i) Front End :-

The front end is used by client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web services (including chrome, firefox, internet

explorer, etc), thin and fat clients, tablets and mobile devices.

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## ii) Back End :

The back end is used by service provider. It manages all 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.

Both front end and back end are connected to others through a network generally using internet connection.

## → Components of Cloud Computing Architecture :-

### i) Client Infrastructure :-

Client Infrastructure is a Front end component. It provides GUI (Graphical User Interface) to interact with cloud.

### ii) Application :-

The application may be any software or platform that a client wants to access.

### iii) Service :-

A cloud service manages that which type of service you access according to client's requirement.

Cloud computing offers 3 types of services :-

#### 1. Software as a Service (SaaS) → It is also known as cloud Application services.

SaaS applications run directly through web browser means we don't need to download & install these applications.

Eg. Google Apps, etc.

#### 2. Platform as a Service (PaaS) → It is also known as cloud Platform services.

It is quite similar to SaaS, but the difference is that PaaS provides a platform for software creation, but using SaaS, we can access software over the internet without any need of platform.

Eg. Windows Azure, force.com, etc.

## Infrastructure as a Service (IaaS) :-

It is also known as cloud infrastructure services. It is responsible for managing applications data, middleware, and runtime environments.

Eg. Amazon web services, Google Compute Engine, etc.

## iv) Cloud Runtime :-

Runtime cloud provides execution and runtime environment to virtual machines.

## v) Storage :-

Storage is one of most important component of cloud computing. It provides a huge amount of storage capacity in cloud to store & manage data.

## vi) Infrastructure :-

Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support cloud computing model.

## vii) Management :-

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

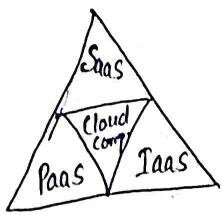
## viii) Security :-

It implements a security mechanism in Backend.

## ix) Internet :-

Internet is medium through which front end and back end can interact & communicate with each other.

## \* Cloud Service Models :-



\* System Administrators use IaaS

### i) Infrastructure as a Structure :-

It is also known as

cloud infrastructure services. IaaS service provider manages all infrastructure, while client is responsible for all other aspects of deployment.

IaaS is one of the most important fundamental service model of cloud computing.

It provides access to computing resources in a virtualized environment "the cloud" on internet.

It provides computing infrastructure like virtual server space, network connections, bandwidth, load balancers & IP addresses.

Amazon web services mainly offers IaaS, which in case of its EC2 service means offering VM's with a software stack that can be customized similar to how an ordinary physical server would be customized.

e.g. Amazon Web Services, Google Compute Engine, etc.

### ii) Software as a service (SaaS) :-

No need to install on PC

Platform independent

\* Users/clients use SaaS

\* Also Known as Cloud Application Services.

SaaS is a software distribution model in which applications are hosted by vendor or service provider and made available to customer over a network.

It is becoming an increasingly prevalent delivery model as underlying technologies that supports Service Oriented Architecture (SOA) or web services.

Through internet this service is available to users anywhere in the world. Salesforce.com, which relies/works on SaaS model, offers business productivity applications (CRM) that reside completely on their servers, allowing customers to customize & access applications on demand. Eg. Google Apps, etc.

## Platform as a service (PaaS)

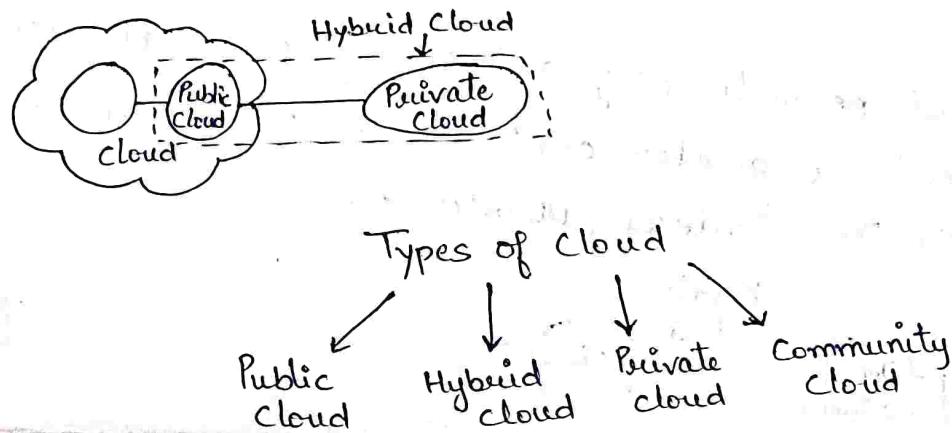
Access to User Interface

It is also known as cloud Platform services.

It provides a platform and environment to allow developers to build applications and services. This service is hosted in cloud & accessed by users via internet.

Eg. Windows Azure, force.com, etc.

## \* Deployment Model :- (Types of Cloud)



A deployment model defines the purpose of cloud & nature of how cloud is located.

It identifies specific type of cloud environment based on ownership, scale, and access as well as cloud's nature & purpose.

It specifies how your cloud infrastructure will look, what you can change & whether you will be given services or will have to create everything yourself.

### i) Public Cloud

The public cloud is available for public use alternatively for a large industry group and is owned by an organization selling cloud services.

This type of cloud is used usually for B2C (Business to consumer) type interactions.

Here computing resource is owned, governed & operated by government or business organization.

Example of those companies which provide public cloud facilities are Amazon EC2, Microsoft Azure, IBM, etc.

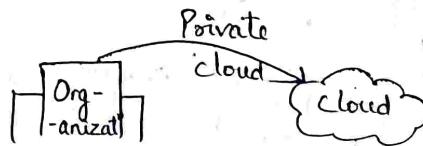
### iii) Private cloud

Private cloud is operated for exclusive use of an organization. The cloud may be managed by that organization or a third party. Here computing resources are deployed for one particular organization. It is available to general public or specific company that owns it private cloud.

So, it is also known as Corporate cloud or Internal cloud. 'Internal cloud' means that it allows accessibility of systems or services within a specific boundary or organization.

Private cloud permits only authorized users, providing the organizations greater control over data & its security.

Examples:- HP Data Centers, Ubuntu, etc.



#### Advantages of Private cloud

- i) Highly Secured
- ii) More Control
- iii) Improved Performance

#### Disadvantages of Private cloud

- i) Costly as compared to Public cloud
- ii) Restricted area of operations

#### Advantages & disadvantages of Public cloud:-

Advantages → i) Low Cost    ii) No Maintenance    iii) High Scalable  
iv) Can be access from anywhere

Disadvantages → i) Less Customizable

### iii) Community cloud

A community cloud is shared by several organizations & supports a specific community that has shared concern.

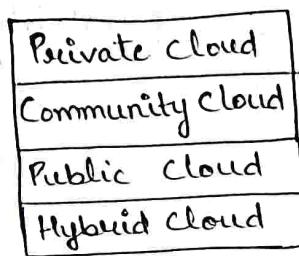
Here, computing resources are provided for a community and organizations. Community cloud is similar to Private cloud, the only difference is set of users.

Here, several organizations with similar background share the infrastructure & related resources.

Community cloud is best for Joint Business Organizations, Research Organizations, etc.

### Hybrid Cloud

Hybrid cloud is combination of two or more clouds such as Private, Public or Community where these clouds retains their unique identities, but are bound together as a unit. This type of cloud can be used on both type of interactions - B2B (Business to Business) or B2C (Business to consumer). This deployment ~~method~~ method is called hybrid cloud as computing resources are bound together by different clouds.



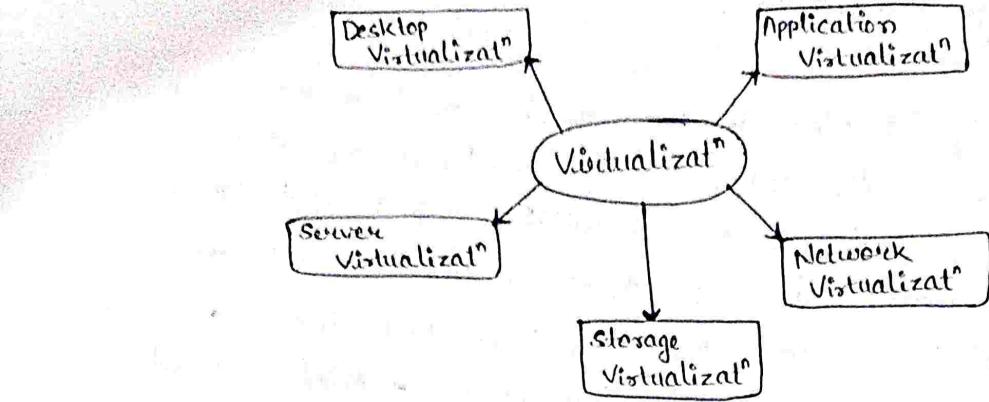
### Virtualization :-

It is a technique which allows us to share single physical instance of a resource or an application among multiple customers & an organization. Virtualization often creates many virtual resources from one physical resource.

It is the "creation of virtual version of something, such as desktop, server, a storage device, an operating system or network resources".

In cloud computing, cloud vendor will provide cloud services, have all physical resources like server, storage device, network device, etc and these physical services are rented by cloud vendors so that user's will not worry about these physical services.

The main usage of virtualization is to provide the application with standard versions to their cloud users. Mainly virtualization means, running multiple operating systems on a single machine but sharing all hardware resources. And it helps us to provide pool of IT resources so, that we can share these IT resources in order to get benefits in business.



### \* Benefits of Virtualization :-

#### 1) Flexibility :-

Organizations have flexibility to share systems without essentially having to share critical information or data across system.

#### 2) Cost Effectiveness

It improves physical security of organizations by reducing hardware requirements.

#### 3) Availability increases with Virtualization :-

It allows virtual instances to be available all the time. It has also the capacity to move virtual instance from one virtual server to another server which is risky task in Server Based system.

#### 4) Disaster Recovery is Efficient & Easy :-

With the help of Virtualization Data Recovery, Backup, Duplication becomes easy.

#### 5) Cloud Migration becomes Easy :-

Most of companies those who already have spent a lot in the server have a doubt of shifting to cloud. But it is more cost-effective to shift to cloud services because all data that is present in their servers can be easily migrated into cloud server & save something from maintenance charge, power consumption, cooling cost, cost to server Maintenance Engineer, etc.

## Drawbacks of Virtualization :-

### i) High Initial Expenditure

- ii) Risk of Data Loss
- iii) Risk of Server Connecting affecting other servers
- iv) Not all applications function well in virtualized environments.

## \* Difference between Cloud Computing & Virtualization.

### Cloud Computing

- 1) Pool & Automate virtual resources for on-demand use.
- 2) High Scalability.
- 3) Very Flexible.
- 4) It provides Infrastructure as a service. (Type of service)
- 5) Multiple Hardwares are required.
- 6) Disaster Recovery depends upon multiple machines.
- 7) It is a methodology of delivering host services over internet.
- 8) It helps to provide resources to a group of users for various tasks.

### Virtualization

- 1) Built multiple simulated environments from one physical hardware system.
- 2) Low Scalability.
- 3) Quite Less flexible.
- 4) Software as a service is its type of service.
- 5) Single Hardware can also work.
- 6) Disaster Recovery depends on single machine.
- 7) A technique of creating a virtual version of a computer hardware platform, storage device or a network resource.
- 8) Helps to deliver packaged resources to a set of users for a particular task.

## \* Server Virtualization :-

It is partitioning of physical server into several virtual servers. It is used to maximize the server resources.

The server virtualization technology is mainly used in web servers by using virtual web servers, it provides low cost web hosting services instead of having separate computer for each web server, we can have number

of virtual servers on same computers.

Server virtualization allows us to use the resources efficiently. With the help of server virtualization, you can eliminate the major cost of hardware. This virtualization in cloud computing can divide workload to multiple servers & all these virtual servers are capable of performing a dedicated task.

One of the reasons for choosing server virtualization is that a person can move workload b/w virtual machine according to load.

Server Virtualization is used:-

- to make more efficient use of server resources.
- to improve server availability.
- to help in disaster recovery.
- Development & Testing.
- to centralize the server administration.

⇒ Advantages / Benefits of Server Virtualization :-

- 1) Each virtual server can be independently rebooted.
- 2) Server virtualization reduces the cost because less hardware is required.
- 3) Server virtualization allows replicating an existing virtual machine.
- 4) Increase Productivity.

\* Virtualization of O/S :-

OS virtualization is a server virtualization technology that involves tailoring a standard OS so that it can run different applications handled by multiple users on a single computer at a time. The OS do not interfere with each other even though they are on same computer.

It provides application-transparent virtualization to users by decoupling applications from OS.

It can also be used to migrate critical applications to another running operating system instance.

In O/S virtualization, the O/S is altered so that it operates like several different, individual systems.

The virtualized environment accepts commands from different users running different applications on same machine.

The users & their requests are handled separately by the virtualized O/S. It is also known as operating system-level virtualization.

### 2) Advantages of O/S virtualization →

- 1) Requires Less space.
- 2) Save Money.
- 3) Less Maintenance.
- 4) ~~less~~ Hardware required.
- 5) Quick Deployment capability.

### \* Network Virtualization →

The ability to run multiple virtual networks with each has a separate control & data plan. It co-exists together on top of one physical network. It can be managed by individual parties that potentially confidential to each other.

Network Virtualization provides a facility to create & provision virtual networks - logical switches, routers, firewalls, load balancer, Virtual Private Network (VPN) & workload security within days or even in weeks.

### \* Application Virtualization →

"Applicat" Virtualizat" helps a user to have remote access of an application from server. The server stores all personal information & other characteristics of application but can still run on local workstation through internet. Example of this would be a user who needs to run two different versions of same sw. Technologies that use application virtualization are hosted applications & packaged - applications.

\* Memory Virtualization → A technique that gives an application program the impression it has its own contiguous logical memory independent of available physical memory. It is a generalization of concept of virtual memory. Virtual memory makes application programming easier to fit in hiding fragmentation of physical memory. In virtual memory implementation, a memory address space is divided into contiguous blocks of fixed size pages.

Benefits to use memory Virtualizat<sup>n</sup> →

- i) Higher memory utilization.
- ii) Ensuring some memory space exit before halting services until memory frees up.
- iii) Access to more memory.
- iv) Advanced server virtualizat<sup>n</sup> functions, like live migrations.

\* CPU Virtualization → CPU Virtualizat<sup>n</sup> emphasizes running programs & instructions through a virtual machine, giving the feel of working on a physical workstation.

All the operation are handled by an emulator that controls s/w to run according to it. With CPU virtualizat<sup>n</sup>, all virtual machines acts as physical machines & distribute their hosting resources like having various virtual processors. Sharing of physical resources takes place to each virtual machine when all hosting services get request. Finally, virtual machines get a share of single CPU allocated to them, being a single processor acting as a dual processor. There are four types of CPU virtualization :- Software-based, Hardware Assisted, Processor specific behaviour, Performance Implications.

\* I/O Devices Virtualizat<sup>n</sup> → I/O virtualizat<sup>n</sup> involves managing the routing of I/O requests between virtual devices & the shared physical hardware. At the time, there are three ways to implement I/O virtualizat<sup>n</sup>: Full Device, Para and direct I/O virtualizat<sup>n</sup>.