

Module 1 - Understanding Virtualisation

1.1

Introduction to virtualisation

* Types of Virtualisation

- CPU virtualization
- Storage virtualization
- Memory virtualization

* Virtualisation of physical computing resources

* Abstraction layer

* Business benefits of virtualisation

* Machine Level and Server Level Virtualisation

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* Type 1 and Type 2 Hypervisors, High level language virtual machine, emulation.

* Adv. and Disadv. of Virtualisation

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* Virtualisation security threats

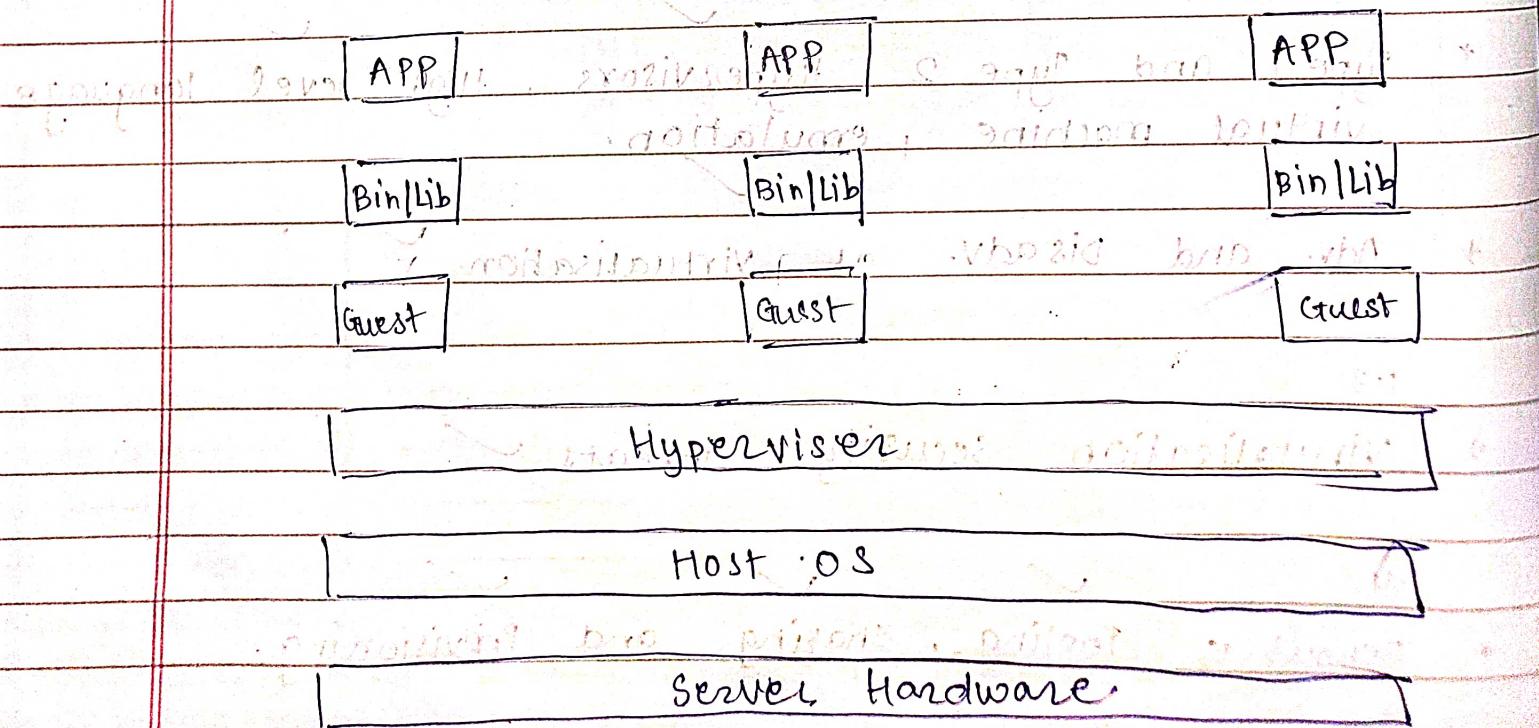
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* Resource Pooling, sharing and provisioning

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* Intro to Virtualisation.

- * Virtualization is a technique to separate service from physical delivery, creating a virtual version of computing resources.
- * It enables simultaneous operations of multiple OS and applications on same hardware.
- * Allows sharing of a single physical instance of a resource or an application among multiple customers and organisations at one time.
- * Fundamental for delivering Infrastructure-as-a-Service (IaaS) solutions for cloud.



Host Machine: The machine on which the virtual machine is going to be built is known as Host Machine.

Guest Machine: The virtual machine is also called guest machine within the host machine.

→ * users store data in the cloud with virtualization enabling additional benefits like infrastructure sharing.

* Types of Virtualisation.

(1) CPU Virtualisation - Allows multiple virtual machines (VMs) or processes to run on a single CPU.

→ This is achieved through hypervisors and virtual machine monitors (VMMs) that manage CPU resources.

→ Increases CPU utilization and efficiency, enables workload consolidation and supports better resource allocation.

(2) Storage Virtualisation - Abstracts physical storage devices into a virtual layer, providing centralized management and improved utilization.

→ facilitates dynamic storage allocation, data redundancy, scalability, and fault tolerance.

③ Memory Virtualisation: Optimizes memory utilization across multiple virtual machines or applications running on a single physical host.

→ Managed by hypervisors and a memory management software.

→ Increases overall system performance, enables efficient memory allocation and supports better workload isolation.

④ OS Virtualisation: Operating system virtualisation which enables multiple isolated instances of operating systems (OS) to run on a single physical machine.

→ Utilizes containers or virtual machines (VMs) to create virtualised OS environments.

→ Enhances resource utilization, supports application isolation, and simplifies deployment.

⑤ Hardware virtualisation : Abstracts physical hardware components, allowing multiple virtual environments to run on a single machine.

→ Implements using hypervisors or hardware-assisted virtualisation techniques.

→ Maximises hardware utilization, improves scalability, facilitates workload isolation, and supports efficient resource allocation.

Virtualisation: of physical computing resources.

After you install a virtualization software on your device, you can create one or more virtual machines.

From the user's perspective, the virtual machine operates like a typical server. It has settings, configurations and installed applications. Computing resources, such as central processing units (CPUs), RAM and storage, appear same as the physical servers.

The hypervisor is a virtualisation software which is installed on your device. It is a software layer that acts as an intermediary b/w VMs and underlying hardware.

For example, If a VM requires computing resources, the request will first go to the hypervisor. The hypervisor passes the request to the underlying hardware.

* Benefits of Virtualisation (Business)

- ① Savings: Moving to virtual servers from physical servers reduces the number of physical servers. Reduces power needs and cooling costs associated with physical servers as well as saves office space.
- ② Testing Environment:- Virtualisation provides a safe environment to test new software, server upgrades and patches. Installing code in a virtual env. provides the opportunity to debug changes in a controlled env. and increase chance of successful deployment.
- ③ Business Continuity: Virtualization decreases the likelihood of hardware failure and decreases the amount of downtime related to such a failure.

All the resources can be sent to a virtual server while the original one is fixed.

- (4) Disaster recovery: Back-ups of virtual servers can be reinstated more quickly than repairing a physical environment.
- (5) Increased security: Web activities can be segregated onto their virtual servers without access to sensitive files, which means any malware installed cannot proliferate through the entire network.

* Abstraction.

- The process of hiding the internal workings of a programme from users of the application and the outside world is known as abstraction.
- In context of cloud it enables users to interact with the cloud without knowing the intricate details of the physical structure.

* Machine or Server Level Virtualisation.

In this part we will discuss

- Server Virtualisation is the process of dividing a physical server into several virtual servers called virtual private servers.
- Each virtual private server can run independently.

* Types of Server Virtualization.

① Hypervisor

- Layer between software and hardware
 - Has two types
- a) Type 1 hypervisor (Also known as bare metal)
 - b) Type 2 hypervisor (Also known as Embedded)
- Mainly used to allocate hardware resources (CPU, RAM, Storage).

② Full Virtualisation

- uses a hypervisor to directly communicate with the CPU and the physical server.

- Provides highest level of isolation and security mechanism to the virtual machines.
- Major disadvantage is that the hypervisor can slow down the application and server performance.
- Eg - VMWare ESX server.

③ Para virtualisation.

- quite similar to full virtualisation - but it doesn't need as much processing power.
- Easier to use, enhanced performance, doesn't require emulation overhead.

④ OS: Virtualisation.

- Also called system virtualisation
- Divides one OS into multiple isolated user-space called virtual environment.
- Major advantage is it reduces use of physical space, so it saves money.

* Advantages of Server Virtualisation

- ① Independent Restart: Each server restarts independently and doesn't affect the working of other virtual servers.
- ② Low Cost: Dividing a single server into multiple virtual private servers reduces cost of hardware components.
- ③ Disaster Recovery: Data can be quickly moved from one server to another.

* Types of Hypervisors

① Type-I hypervisor

- Acts like a lightweight OS and runs directly on the host hardware.
- Isolated from attack prone OS, so are extremely secure.
- Also called bare-metal hypervisor.

② Type - 2 Hypervisor

- Runs on top of the OS of the host machine.
- Additional softwares or OS can be installed on top of the hypervisor.
- Latency is higher than Type-1 hypervisor.

* High-level Language Virtual Machine (HLL VM)

- HLL VM is a type of VM that is used in cloud computing to run high-level programming languages.
- Provides developers with cross-platform compatibility.
- Translates high-level code into an intermediate representation, which serves as a platform-independent service.
- Includes memory management features like garbage collection and memory allocation/deallocation to abstract the complexity of memory management.

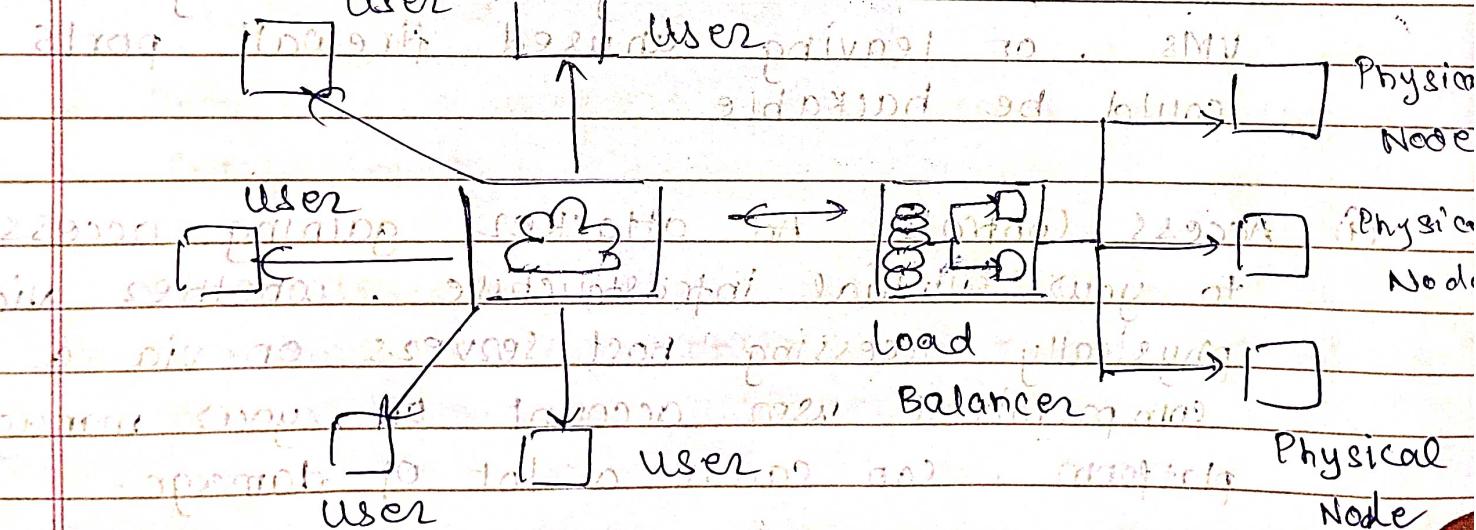
* Virtualisation security threats

- ① VM Sprawl : Virtual machine sprawl is an uncontrollable spread of VMs created for specific workloads but then abandoned. Leads to VMs with sensitive information being compromised.
- ② Malware and Ransomware Attacks: VMs are susceptible to viruses, malware etc. Once a VM is infected, it can spread malware across the entire virtual infrastructure.
- ③ Network Configuration: Making poor configuration choices, like allowing file sharing b/w VMs, or leaving unused firewall ports open could be hackable.
- ④ Access Controls: An attacker gaining access to your virtual infrastructure, whether via physically accessing host servers or via a compromised user account on your management platform, can cause a lot of damage.
- ⑤ Workloads with different trust levels: Without proper security controls, it's easy to create a test server that should be on low-trust zone, on the same physical hardware as a live production server with sensitive information.

* Resource Pooling

- A resource pool is a group of resources that can be assigned to user resources of any kind including computation, network and storage. Can be pooled.
- Any resource from this pool can be shared to several users or apps.
- Resources are dynamically allocated rather than permanently allocated.

* Architecture of Resource pooling



Physical Server Pools

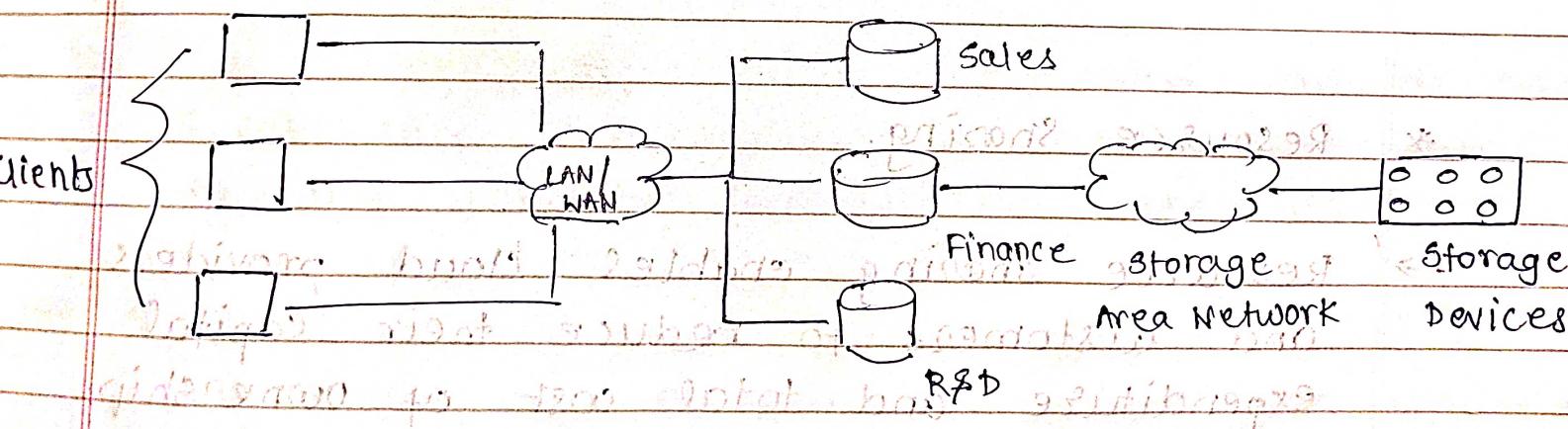
- Collection of physical servers that are networked together and are ready to use right away.

* Virtual Server Pools

- Network collection of virtual servers that have OS and other required software installed and are ready to use.
- Typically, they are set up using one of the many accessible templates that the cloud consumer has selected during provisioning.

* Cloud Storage Pools

- Collection of block or file-based storage structure that house both empty and/or populated cloud storage devices.



* Network Pools

- It is a collection of several preset network connectivity devices, such as virtual firewall device pool or physical network switches.

- Through network infrastructure, resources in pools can be linked to one another
- Switches, routers, gateways and other networking hardware make up the network pool.
- * CPU pools
- Collection of processing units that are prepared to be assigned to virtual servers and are often divided into separate processing cores.
- Smaller pools can contribute towards making larger pools.

* Resource Sharing.

- Resource sharing enables cloud providers and customers to reduce their capital expenditure and total cost of ownership.
- Multiple cloud service providers connect to form a federation to share their resources among themselves.

- Resources are available over the network and accessed through standard mechanisms that promote reuse by heterogeneous, thin or thick client platforms.
- Capabilities like automatic scaling, allowing elasticity and availability optimization.

* Resource Provisioning:

- Resource provisioning in cloud computing refers to the process of allocating and configuring computing resources such as VMs and storage and networking infrastructures.

* Types of Resource Provisioning

- ① Static provisioning: static provisioning can be used successfully for applications with known and typically constant demand or workloads.
 - A cloud provider allows the customer with a set number of resources. The client can utilize these resources as required.

② Dynamic Provisioning: With dynamic provisioning, provider adds resources as needed and subtracts them when they are no longer needed.

- Also known as pay-as-you-go model.
- Clients are billed as per the amount of resources used.

③ Self-service provisioning: Customer uses a web form to acquire resources from the cloud provider sets up a customer account and pays with credit card to utilize resources.

- * Emulation: A technique where a Virtual Machine (VM) simulates complete hardware in software.
- Emulation is a technique where a Virtual Machine (VM) simulates complete hardware in software.
- An emulator mimics the qualities and logic of one processor to run in another platform efficiently.

* Advantages of Virtualization.

- ① Cheap
- ② Efficient
- ③ Disaster Recovery.
- ④ Deployment

= Disadvantages of Virtualisation.

- 1) High cost of implementation
- 2) Availability problems
- 3) Time-intensive

Restraints.