VIRTUALIZATION AND HYPERVISORS

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Learning Outcomes:-

- 2.1 Introduction to Cloud virtualization
- 2.2 Characteristics of virtualization
- 2.3 Cloud Virtualization Basics
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- 2.3.3 Full virtualization
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- 2.5.1 Introduction to Hypervisors
- (Type 1 and Type2)
- 2.5.2 Creating and managing Virtual Machines
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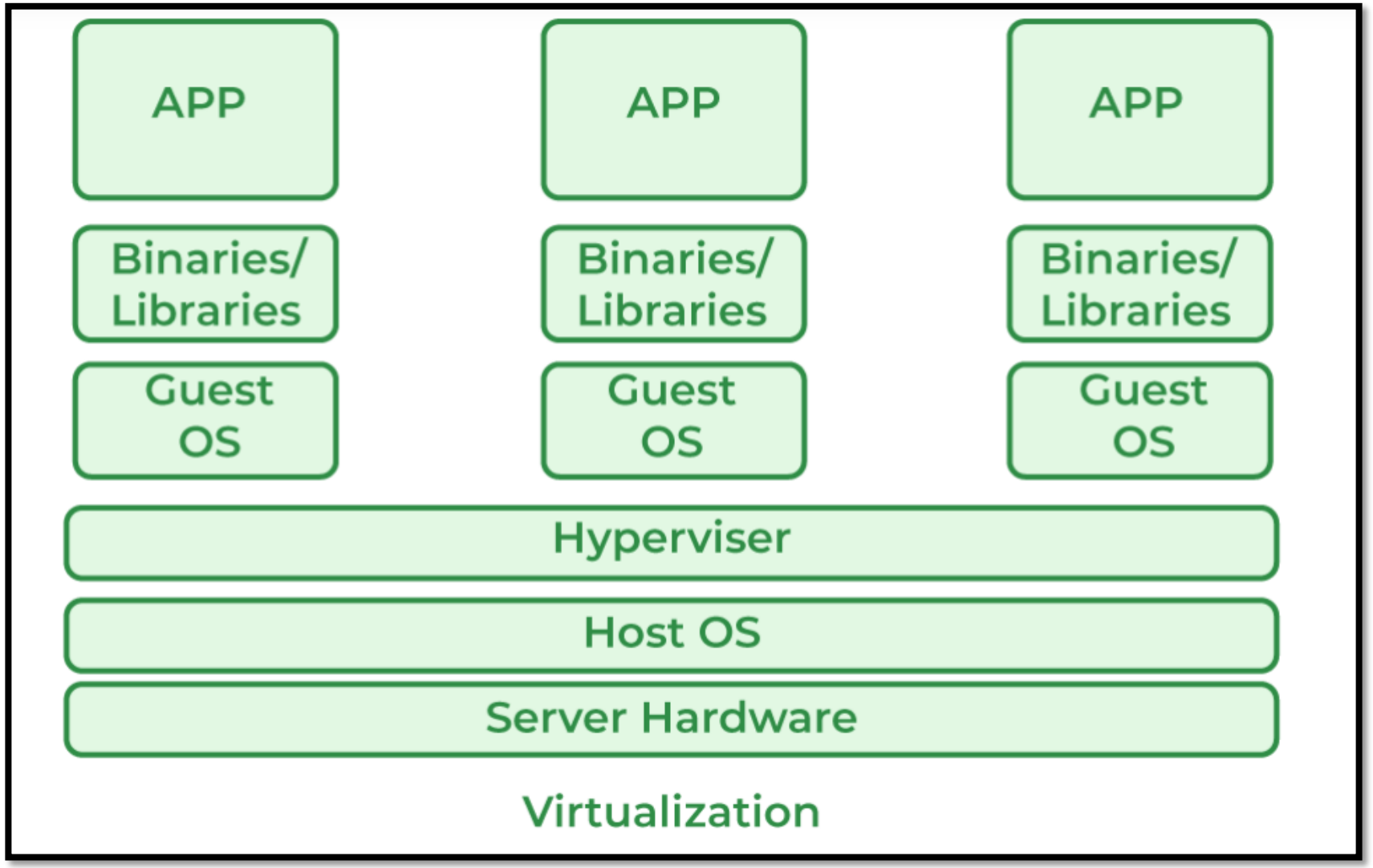
INTRODUTION TO Cloud virtualization

- Virtualization is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources".
- Virtualization is a technique, which allows to share a single physical instance of a resource or an application among multiple customers and organizations.
- It does by assigning a logical name to a physical storage and providing a pointer to that physical resource when demanded.
- Creation of a virtual machine over existing operating system and hardware is known as Hardware Virtualization.
- A Virtual machine provides an environment that is logically separated from the underlying hardware.
- The machine on which the virtual machine is going to create is known as Host Machine and that virtual machine is referred as a Guest Machine.

INTRODUTION TO Cloud virtualization

- Virtualization is a technique how to separate a service from the underlying physical delivery of that service.
- It is the process of creating a virtual version of something like computer hardware.
- With the help of Virtualization, multiple operating systems and applications can run on the same machine and its same hardware at the same time, increasing the utilization and flexibility of hardware.
- In other words, one of the main cost-effective, hardware-reducing, and energy-saving techniques used by cloud providers is Virtualization.
- Virtualization allows sharing of a single physical instance of a resource or an application among multiple customers and organizations at one time.
- The term virtualization is often synonymous with hardware virtualization, which plays a fundamental role in efficiently delivering Infrastructure-as-a-Service (IaaS) solutions for cloud computing.

INTRODUTION TO Cloud virtualization



INTRODUTION TO Cloud virtualization

Advantages of Virtualization:-

- More flexible and efficient allocation of resources.
- Enhance development productivity.
- It lowers the cost of IT infrastructure.
- Remote access and rapid scalability.
- High availability and disaster recovery.
- Pay peruse of the IT infrastructure on demand.
- Enables running multiple operating systems.

INTRODUTION TO Cloud virtualization

Disadvantages of Virtualization:-

- High Initial Investment
- Learning New Infrastructure
- Risk of Data

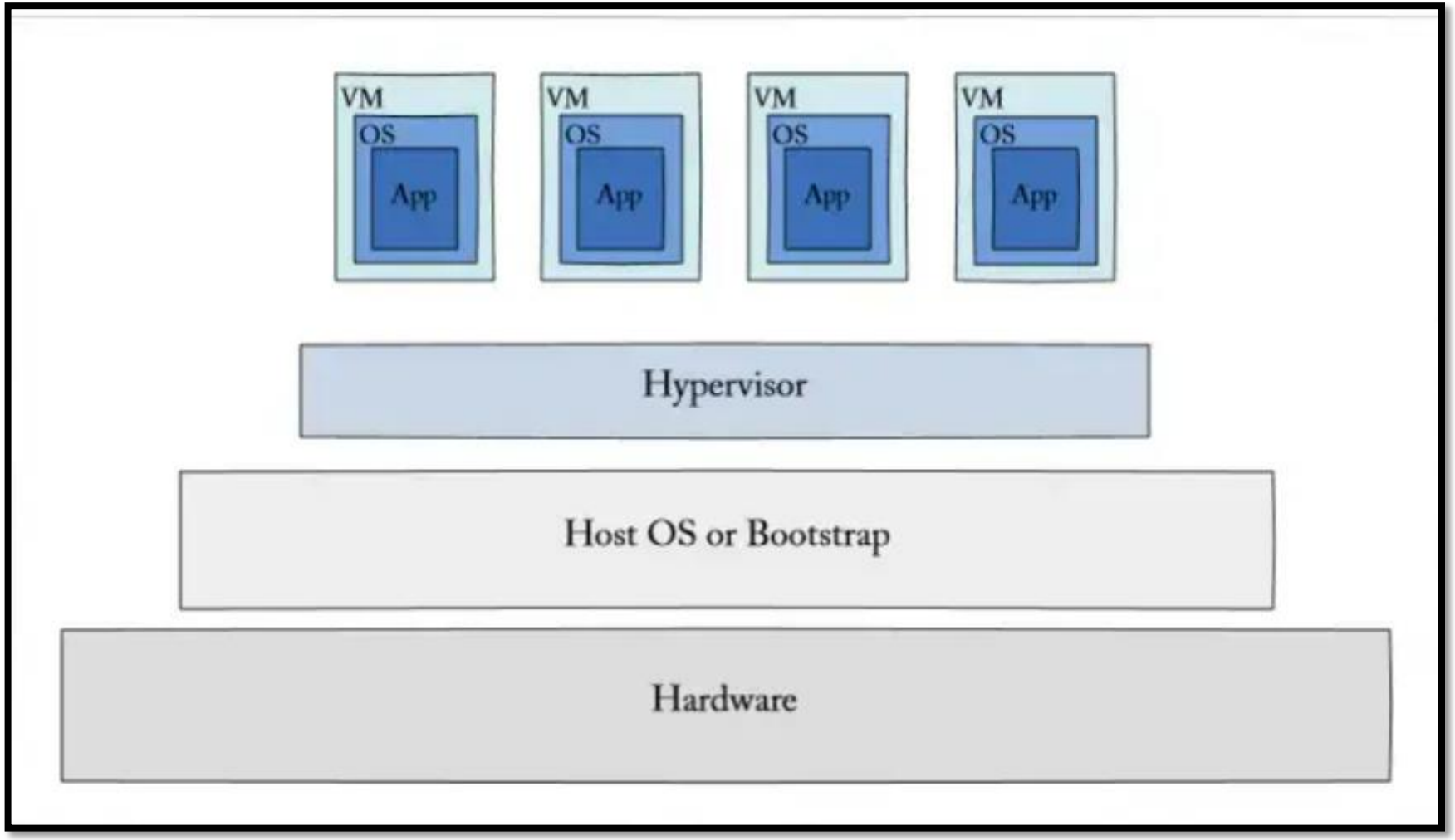
Characteristics of virtualization

- **Increased Security:** The ability to control the execution of a guest program in a completely transparent manner opens new possibilities for delivering a secure, controlled execution environment.
- All the operations of the guest programs are generally performed against the virtual machine, which then translates and applies them to the host programs.
- **Managed Execution:** In particular, sharing, aggregation, emulation, and isolation are the most relevant features.
- **Sharing:** Virtualization allows the creation of a separate computing environment within the same host.
- **Aggregation:** It is possible to share physical resources among several guests, but virtualization also allows aggregation, which is the opposite process.

Characteristics of virtualization

- **Resource Isolation:** Virtualization provides isolated virtual machines. Each virtual machine can have many guest users, and guest users could be either operating systems, devices, or applications.
- The virtual machine provides such guest users with an isolated virtual environment. This ensures that the sensitive information remains protected, and, at the same time, guest users remain inter-connected with one another.
- **Distribution of resources:** Virtualization and Cloud Computing technology ensure end-users develop a unique computing environment.
- It is achieved through the creation of one host machine. Through this host machine, the end-user can restrict the number of active users. They can also be used to bring down power consumption.

Cloud Virtualization Basics



Cloud Virtualization Basics

- **Hypervisor:** Also known as a Virtual Machine Monitor (VMM), the hypervisor is responsible for creating and managing virtual machines on the physical hardware. There are two types of hypervisors: Type 1 (bare-metal) hypervisors run directly on the hardware, while Type 2 (hosted) hypervisors run on top of an operating system.
- **Virtual Machine (VM):** A virtualized instance of a computer system that runs an operating system. Multiple VMs can coexist on a single physical machine, each with its own isolated environment.
- **Host Machine:** The physical hardware that runs the hypervisor and hosts one or more virtual machines.
- **Guest Operating System:** The operating system running inside a virtual machine. Multiple guest operating systems can run concurrently on the same host machine.

Cloud Virtualization Basics

- There are several approaches or ways to virtualizes cloud servers.
- **Grid Approach:** where the processing workloads are distributed among different physical servers, and their results are then collected as one.
- **OS - Level Virtualization:** Here, multiple instances of an application can run in an isolated form on a single OS.
- **Hypervisor-based Virtualization**: which is currently the most widely used technique
- With hypervisor's virtualization, there are various sub-approaches to fulfill the goal of running multiple applications & other loads on a single physical host.
- A technique is used to allow virtual machines to move from one host to another without shutting down. This technique is termed as "Live Migration".

Cloud Virtualization Basics

- Hardware virtualization
- Software Virtualization
- Full virtualization
- Para virtualization
- Partial virtualization
- Operating system level virtualization

Cloud Virtualization Basics

Hardware virtualization:-

- When the virtual machine software or virtual machine manager (VMM) is directly installed on the hardware system is known as **hardware virtualization.**
- The main job of hypervisor is to control and monitoring the processor, memory and other hardware resources.
- It is the abstraction of computing resources from the software that uses cloud resources.
- It involves embedding virtual machine software into the server's hardware components. That software is called the **hypervisor.**
- The hypervisor manages the shared physical hardware resources between the guest OS & the host OS.
- The abstracted hardware is represented as actual hardware.

Cloud Virtualization Basics

Hardware virtualization:-

- Virtualization means abstraction & hardware virtualization is achieved by abstracting the physical hardware part using Virtual Machine Monitor (VMM) or hypervisor.
- Hypervisors rely on command set extensions in the processors to accelerate common virtualization activities for boosting the performance.
- The term hardware virtualization is used when VMM or virtual machine software or any hypervisor gets directly installed on the hardware system.
- After virtualization of hardware system we can install different operating system on it and run different applications on those OS.
- **Usage:** Hardware virtualization is mainly done for the server platforms, because controlling virtual machines is much easier than controlling a physical server

Cloud Virtualization Basics

Advantages Hardware virtualization:-

- **Lower Cost:** Because of server consolidation, the cost decreases; now, multiple OS can exist together in a single hardware. This minimizes the quantity of rack space, reduces the number of servers, and eventually drops the power consumption.
- **Efficient resource utilization:** Physical resources can be shared among virtual machines. Another virtual machine can use the unused resources allocated by one virtual machine in case of any need.
- **Increase IT flexibility:** The quick development of hardware resources became possible using virtualization, and the resources can be managed consistently also.
- **Advanced Hardware Virtualization features:** With the advancement of modern hypervisors, highly complex operations maximize the abstraction of hardware & ensure maximum uptime. This technique helps to migrate an ongoing virtual machine from one host to another host dynamically.

Cloud Virtualization Basics

Types of Hardware virtualization:-

- Full Virtualization
- Para Virtualization
- Emulation Virtualization

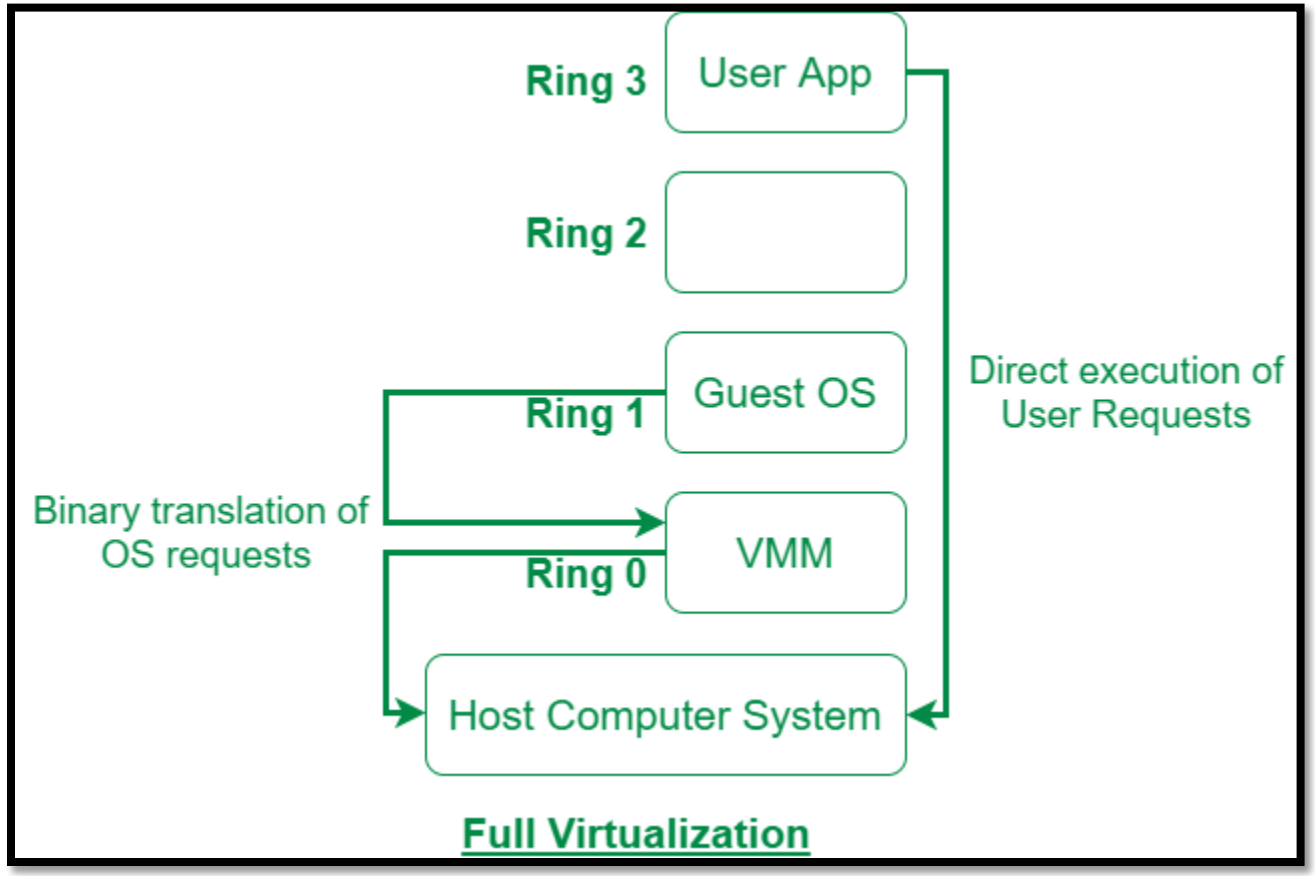
Cloud Virtualization Basics

Full virtualization:-

- Full Virtualization was introduced by IBM in the year 1966.
- It is the first software solution for server virtualization and uses binary translation and direct approach techniques.
- In full virtualization, guest OS is completely isolated by the virtual machine from the virtualization layer and hardware.
- In the full virtualization technique, the hypervisor completely simulates the underlying hardware.
- The main advantage of this technique is that it allows the running of the unmodified OS. In full virtualization, the guest OS is completely unaware that it's being virtualized.
- Full virtualization uses a combination of **direct execution and binary translation**. This allows direct execution of non-sensitive CPU instructions, whereas sensitive CPU instructions are translated on the fly.

Cloud Virtualization Basics

Full virtualization:-



Cloud Virtualization Basics

Full virtualization:-

- To improve performance, the hypervisor maintains a cache of the recently translated instructions.
- Full virtualization is commonly used in enterprise environments, data centers, and cloud computing to enable the efficient use of hardware resources, facilitate server consolidation, and support the deployment of multiple operating systems on a single physical machine.

Examples of Full Virtualization Hypervisors:

- VMware ESXi
- Microsoft Hyper-V
- KVM (Kernel-based Virtual Machine)
- Xen (when configured for full virtualization)

Cloud Virtualization Basics

Advantages of Full virtualization:-

- **Isolation:**
- Full virtualization provides strong isolation between virtual machines. Each VM operates independently of others, with its own dedicated set of resources, ensuring that activities in one VM do not impact others.
- **Flexibility and Portability:**
- Virtual machines can be easily moved or copied between physical hosts, providing flexibility in workload management, resource allocation, and disaster recovery.
- **Resource Optimization:**
- Multiple virtual machines can run on a single physical host, optimizing resource utilization and reducing hardware requirements. This leads to cost savings and improved efficiency.

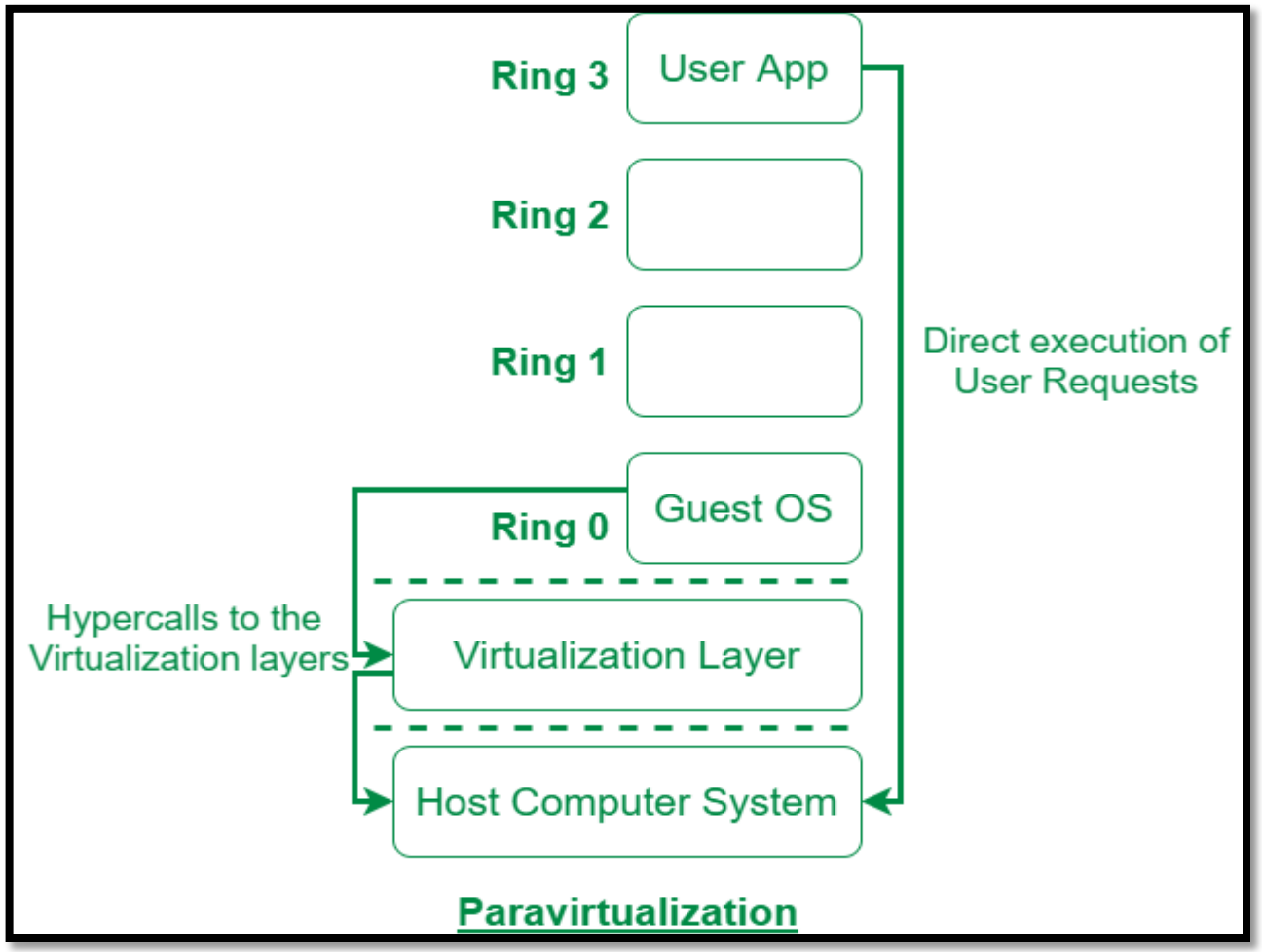
Cloud Virtualization Basics

Para virtualization:-

- Para virtualization is the category of CPU virtualization which uses hypercalls for operations to handle instructions at compile time.
- In para virtualization, guest OS is not completely isolated but it is partially isolated by the virtual machine from the virtualization layer and hardware.
- VMware and Xen are some examples of para virtualization.
- The interaction of the guest operating system with the hypervisor to improve performance and productivity is known as para virtualization.
- It also alters the operating system kernel to use hypercalls rather than non-virtualizable instructions.
- The goal of hypercalls is to communicate with the virtualization layer hypervisor directly.

Cloud Virtualization Basics

Para virtualization:-



Cloud Virtualization Basics

Para virtualization:-

- The hypervisor performs different functions in para virtualization, such as the layout of the hypercalls interface for other critical kernel services like memory management, timekeeping, and interrupt handling.
- The main benefit of para virtualization is that it may significantly minimize virtualization overhead.

Examples of Para virtualization Platforms:

- Xen: Xen is a hypervisor that supports both full virtualization and para virtualization.
- In the para virtualization mode, guest operating systems are modified to run on the Xen hypervisor more efficiently.

Cloud Virtualization Basics

Advantages of Para virtualization:-

Improved Performance:

- Para virtualization can provide better performance compared to full virtualization in certain scenarios. By modifying the guest operating system to be aware of the virtualization layer, certain operations can be optimized, reducing overhead and improving overall system performance.

Reduced Overhead:

- Since the guest operating system in para virtualization is aware of the hypervisor and communicates directly with it through hypercalls or API calls, there is less need for emulation of certain instructions. This reduction in emulation overhead contributes to improved efficiency.

Enhanced I/O Performance:

- One of the notable areas where para virtualization excels is in improving I/O (Input/Output) performance. By using optimized interfaces for communication between the guest OS and the hypervisor, I/O operations can be streamlined and operate more efficiently.

Cloud Virtualization Basics

Software Virtualization:-

- Managing applications and distribution becomes a typical task for IT departments. Installation mechanism differs from application to application.
- Some programs require certain helper applications or frameworks and these applications may have conflict with existing applications.
- Software virtualization is just like a virtualization but able to abstract the software installation procedure and create virtual software installations.
- Virtualized software is an application that will be "installed" into its own self-contained unit.
- Software Visualization in Cloud Computing allows the single computer server to run one or more virtual environments.
- It is quite similar to virtualizations but here it abstracts the software installation procedure and creates a virtual software out of it.

Cloud Virtualization Basics

Software Virtualization:-

- In software virtualizations, an application will be installed which will perform the further task.
- One software is physical while others are virtual as it allows 2 or more operating system using only one computer.
- Example of software virtualization is VMware software, virtual box etc.

Cloud Virtualization Basics

Types of Software Virtualization:-

OS Virtualization

- In OS Virtualization, more than the Operating system wants to work individually to complete the task without affecting others. Thus, a particular Operating system can perform its specified job.

Application Virtualization

- Application Virtualization is the second Virtualization method where users can remotely access their applications on the central server. It helps to run multiple applications at the same time by building a virtual environment.

Service Virtualization

- Service Virtualization is a technique to simulate the Behaviors of components in the form of combination component-based applications..

Cloud Virtualization Basics

Advantages Software Virtualization:-

Client Deployments Become Easier:

- Copying a file to a workstation or linking a file in a network then we can easily install virtual software.

Easy to manage:

- To manage updates becomes a simpler task. You need to update at one place and deploy the updated virtual application to the all clients.

Software Migration:

- Without software virtualization, moving from one software platform to another platform takes much time for deploying and impact on end user systems. With the help of virtualized software environment the migration becomes easier.

Cloud Virtualization Basics

Hardware Virtualization	Software Virtualization
The host offers hardware support to the guest deploying a scenario where the code is executed directly on the host. This allows both host and guest to use the same platform.	In Software virtualization, it is the operating system that is virtualized. Thus, the platform for OS virtualization is independent.
For hardware virtualization, it is only the hardware that is shared.	With Software virtualization, both the hardware and the software of the host are virtualized.
Hardware virtualization keeps the RAM and CPU secluded.	Software virtualization entails sharing the RAM and CPU.
The virtualization solution used to support hardware virtualization is VM-ware and Hypervisor.	The virtualization solution incorporated for Software virtualization is Virtuozzo.
To upgrade the OS, hardware virtualization doesn't experience issues as it is independent.	For Software virtualization, the guest operating system cannot be updated until and unless the system of the host is updated.

Cloud Virtualization Basics

Operating system level virtualization:-

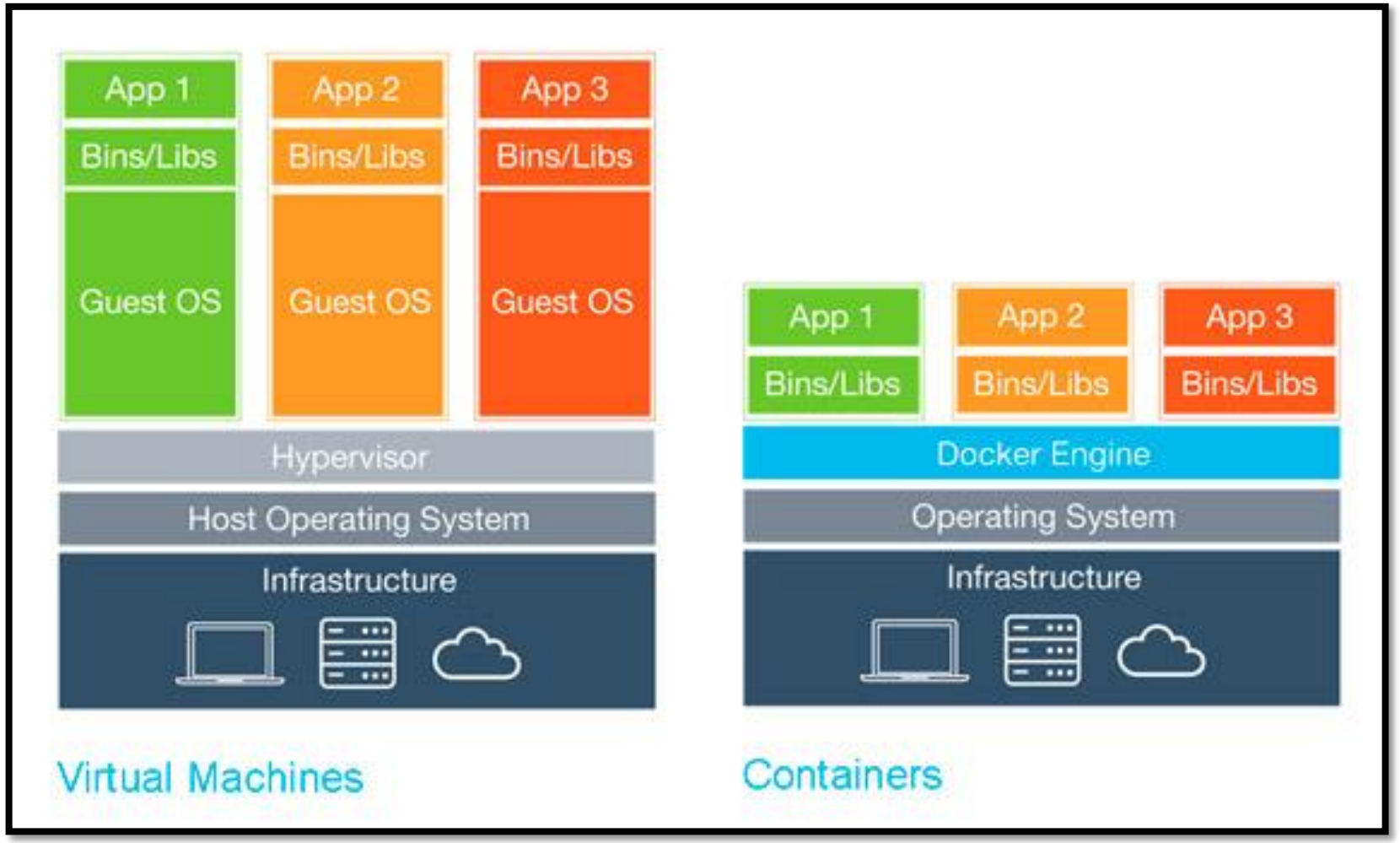
- Operating System-level virtualization, also known as containerization, is a virtualization approach where multiple isolated user-space instances, called containers, share the same host operating system (OS) kernel.
- Unlike traditional virtualization, where each virtual machine (VM) runs its own OS and kernel, containers share the underlying OS and kernel but are isolated from each other at the user-space level.

Examples:

- Docker: Docker is one of the most popular containerization platforms.
- It allows developers to package applications and their dependencies into containers, ensuring consistent and reproducible deployment across different environments.

Cloud Virtualization Basics

Operating system level virtualization:-



Cloud Virtualization Basics

Operating system level virtualization:-

Key characteristics of Operating System-level virtualization include:

Containers:

- Containers are lightweight, portable, and self-sufficient units that encapsulate an application and its dependencies. They include only the necessary components to run the application and share the host OS kernel.

Isolation:

- Containers provide process-level isolation, meaning each container runs as an isolated process on the host OS. They have their file system, network space, and process space, ensuring that applications within one container do not interfere with those in another.

Efficiency:

- Operating System-level virtualization is more resource-efficient compared to traditional virtualization. Since containers share the host OS kernel, they have lower overhead, faster startup times, and consume fewer system resources than full VMs.

Types of Virtualization

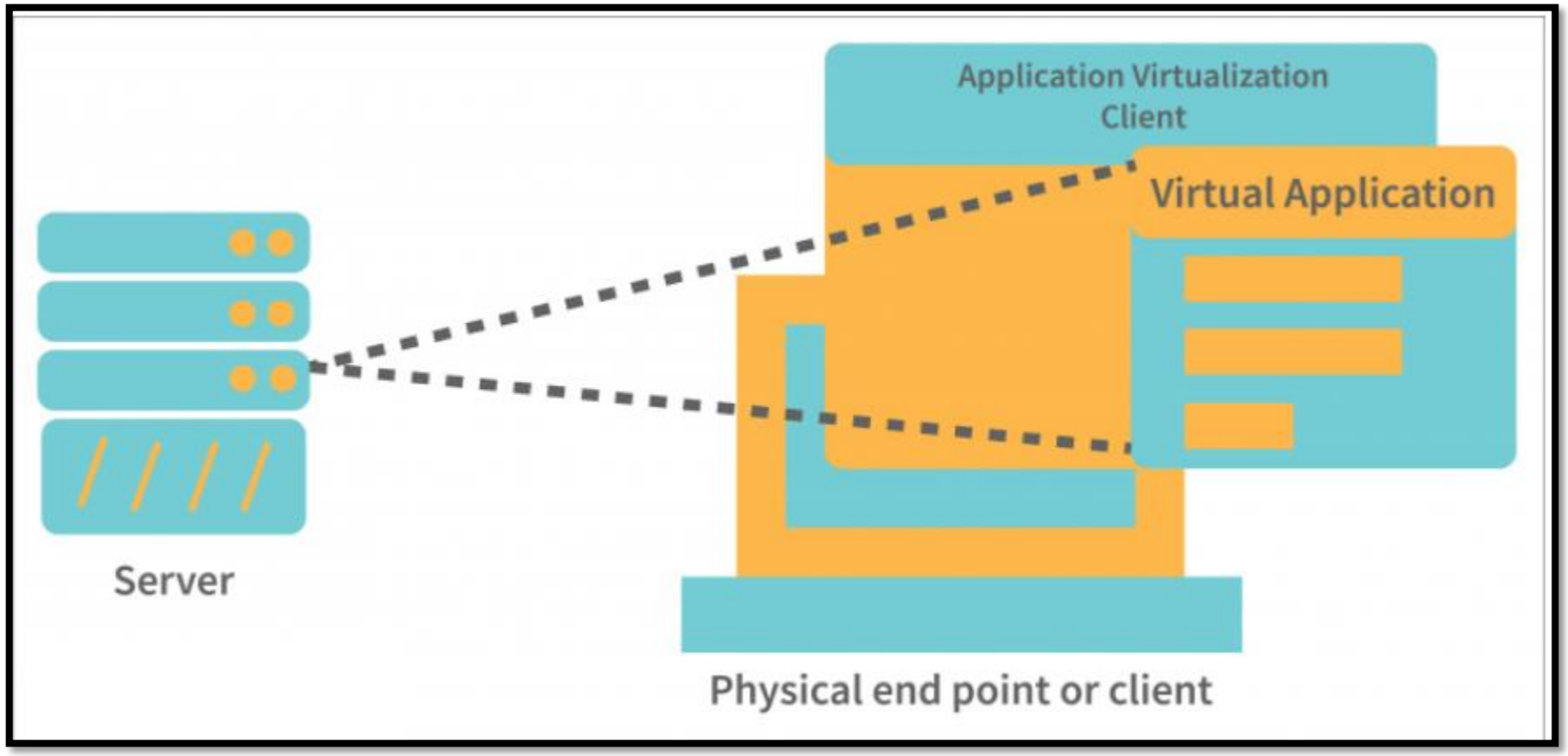
- Application Virtualization
- Network Virtualization
- Desktop Virtualization
- Storage Virtualization
- Server Virtualization
- Data virtualization

Types of Virtualization

- **Application Virtualization:-**
- Application virtualization helps a user to have remote access to an application from a server.
- The server stores all personal information and other characteristics of the application but can still run on a local workstation through the internet.
- Application virtualization refers to the process of deploying a computer application over a network (the cloud).
- The deployed application is installed locally on a server, and when a user requests it, an instance of the application is displayed to them.
- The user can then engage with that application as if it was installed on their system.
- Application virtualization is a powerful concept that takes away most of the drawbacks of installing applications locally.
- Users can also run applications not supported by their devices' operating systems.

Types of Virtualization

- **Application Virtualization:-**



Types of Virtualization

- **Application Virtualization:-**
- Example: Docker, Microsoft App-V, Citrix XenApp.
- To achieve application virtualization, follow these practices:
- **Application streaming** – Users stream the application from a remote server, so it runs only on the end user's device when needed.
- **Server-based application virtualization** – Users can access the remote application from their browser or client interface without installing it.
- **Local application virtualization** – The application code is shipped with its own environment to run on all operating systems without changes.

Types of Virtualization

- **Application Virtualization:-**

Advantages:

- Compatibility and Isolation
- Simplified Deployment
- Flexibility and Portability

Disadvantages:

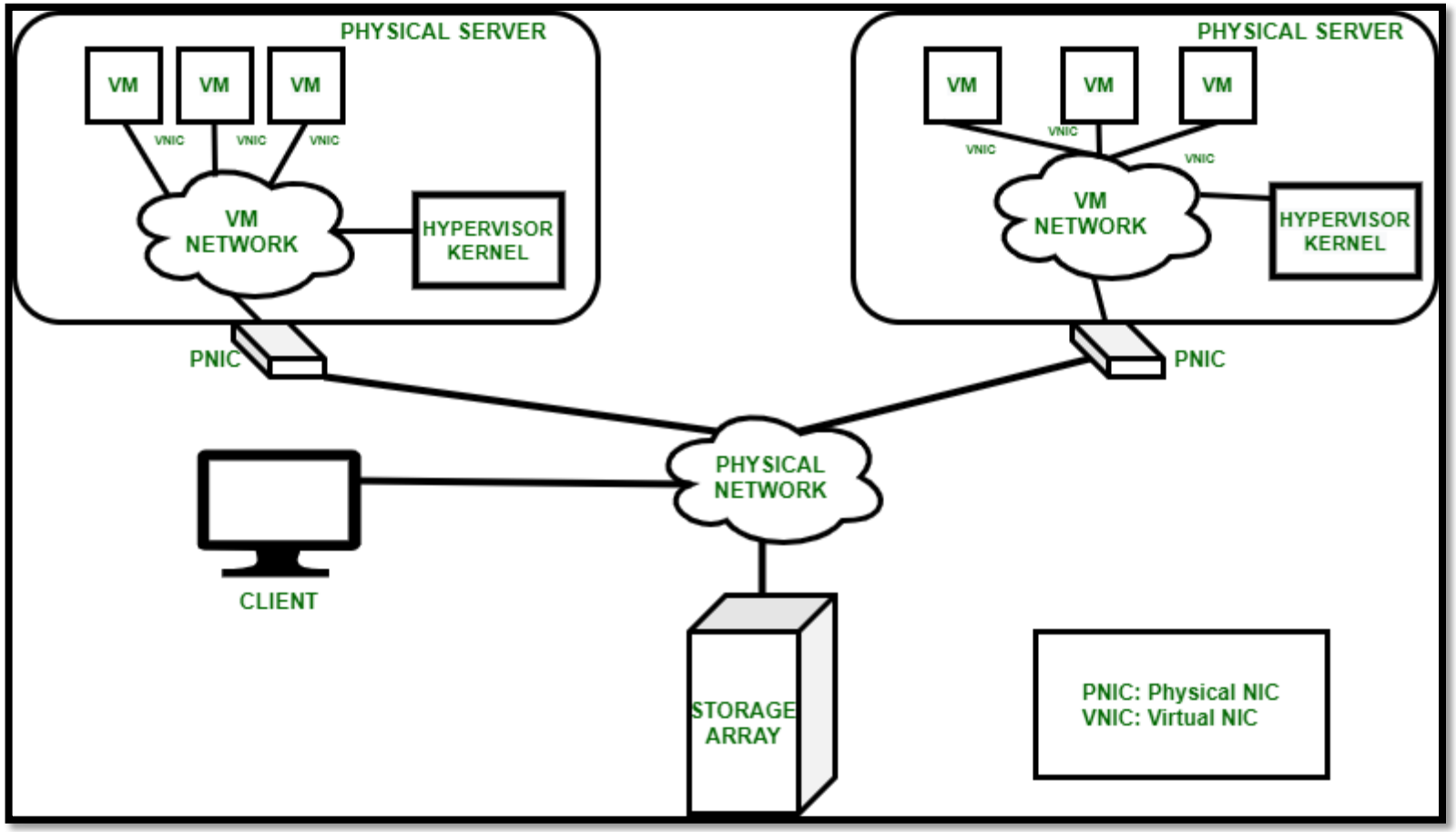
- Performance Overhead
- Complexity for Certain Applications

Types of Virtualization

- **Network Virtualization:-**
- Any computer network has hardware elements such as switches, routers, and firewalls.
- An organization with offices in multiple geographic locations can have several different network technologies working together to create its enterprise network.
- Network virtualization is a process that combines all of these network resources to centralize administrative tasks.
- Administrators can adjust and control these elements virtually without touching the physical components, which greatly simplifies network management.
- In this, the software creates a virtual instance of the network that can be used to manage from a single console.
- It forms the abstraction of the hardware components and functions (e.g., switches, routers, etc.), simplifying network management.

Types of Virtualization

- **Network Virtualization:-**



Types of Virtualization

- **Network Virtualization:-**
- Example: Cisco ACI (Application Centric Infrastructure), VMware NSX, Open vSwitch.
- The following are two approaches to network virtualization.

Software-defined networking:-

- Software-defined networking (SDN) controls traffic routing by taking over routing management from data routing in the physical environment.
- For example, you can program your system to prioritize your video call traffic over application traffic to ensure consistent call quality in all online meetings.

Network function virtualization:-

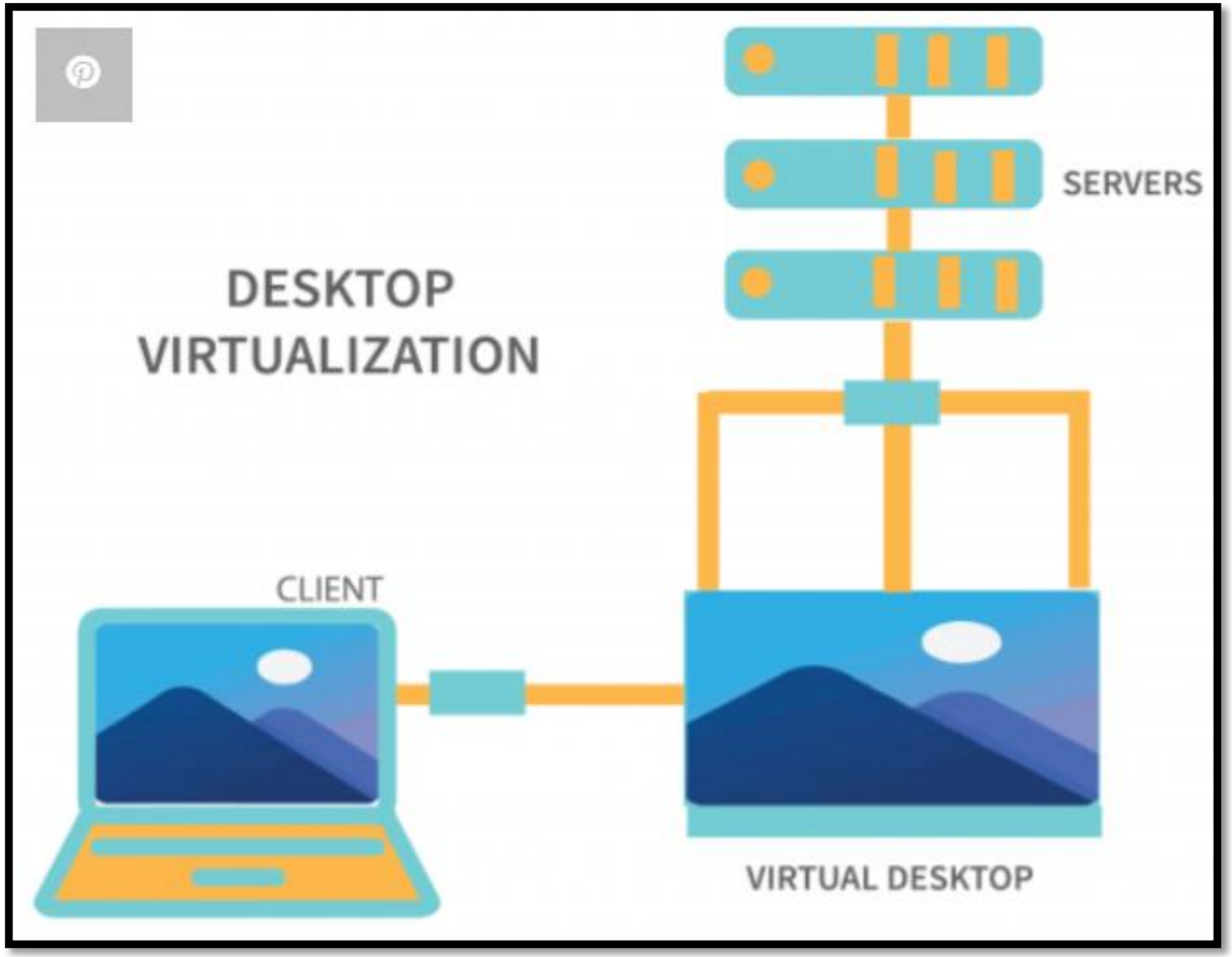
- Network function virtualization technology combines the functions of network appliances, such as firewalls, load balancers, and traffic analyzers that work together, to improve network performance.

Types of Virtualization

- **Desktop Virtualization:-**
- Most organizations have nontechnical staff that use desktop operating systems to run common business applications.
- For instance, you might have the following staff:
- A customer service team that requires a desktop computer with Windows 10 and customer-relationship management software
- A marketing team that requires Windows Vista for sales applications
- You can use desktop virtualization to run these different desktop operating systems on virtual machines, which your teams can access remotely.
- This type of virtualization makes desktop management efficient and secure, saving money on desktop hardware.
- In this type of virtualization, you can run multiple operating systems, each in its own virtual machine on the same system.
- Desktop virtualization is similar to application virtualization, but the apps are now replaced with whole desktop environments.

Types of Virtualization

- **Desktop Virtualization:-**



Types of Virtualization

- **Desktop Virtualization:-**
- The main benefits of desktop virtualization are user mobility, portability, and easy management of software installation, updates, and patches.
- Example: Citrix Virtual Apps and Desktops, VMware Horizon, Microsoft Remote Desktop Services.
- **Virtual desktop infrastructure:-**
- Virtual desktop infrastructure runs numerous virtual machines on a central server and then hosts it to the host system according to the user's requirements.
- In this way, you can access any operating system from any device without installing the actual operating system in their local machine.

Local desktop virtualization:-

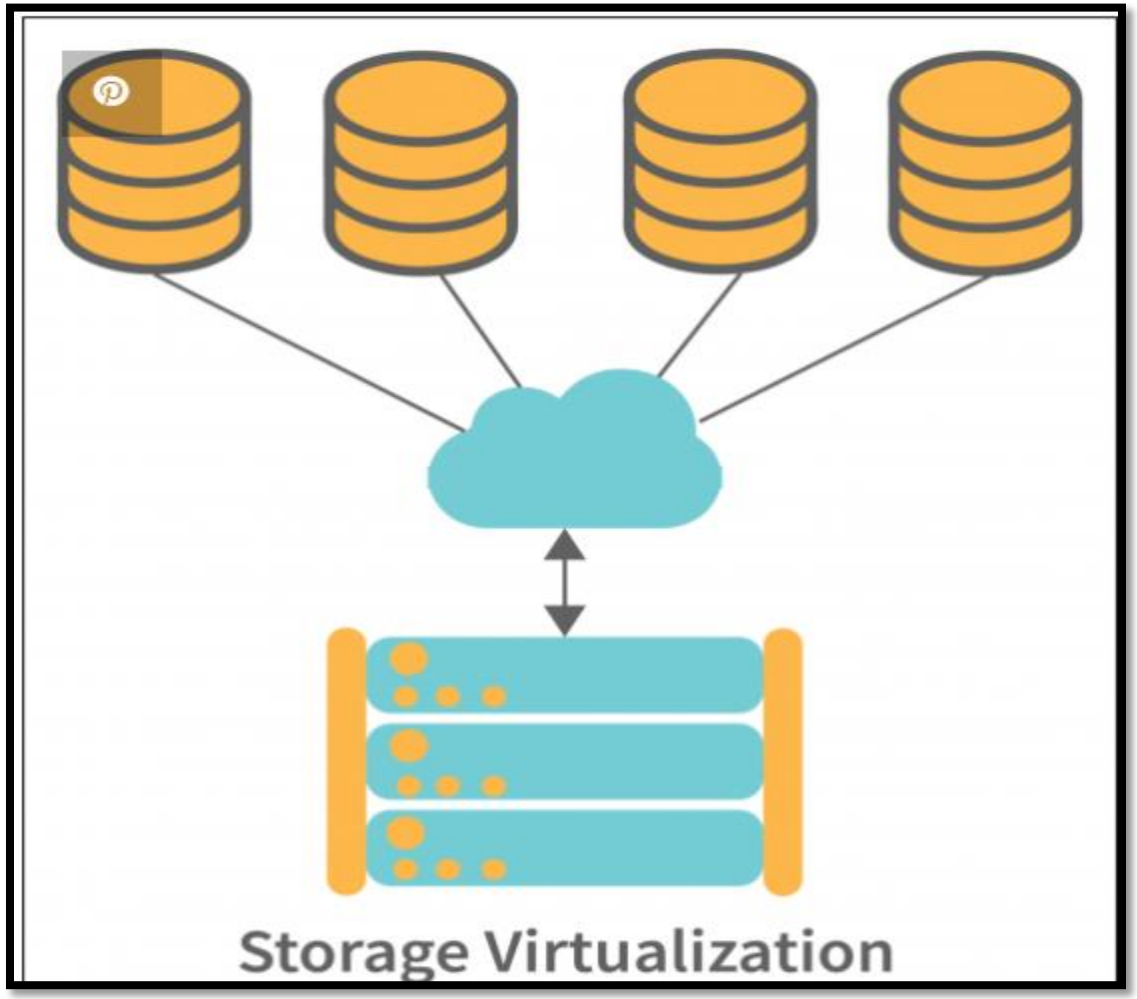
- In local desktop virtualization, you run the hypervisor on a local computer and create a virtual computer with a different operating system.
- You can switch between your local and virtual environment in the same way you can switch between applications.

Types of Virtualization

- **Storage Virtualization:-**
- This virtualization enables all the storage devices on the system to be accessed and be managed as a single storage unit pool for better maintenance.
- The storage virtualization collects all the storage into a single pool from which they can allocate to any of the VM on the network as required.
- This step makes it easier for the hypervisor to assign storage for VMs with max efficiency and without wasting any hardware resources from our system.
- Storage virtualization combines the functions of physical storage devices such as network attached storage (NAS) and storage area network (SAN).
- Storage virtualization uses all your physical data storage and creates a large unit of virtual storage that you can assign and control by using management software.

Types of Virtualization

- **Storage Virtualization:-**



Types of Virtualization

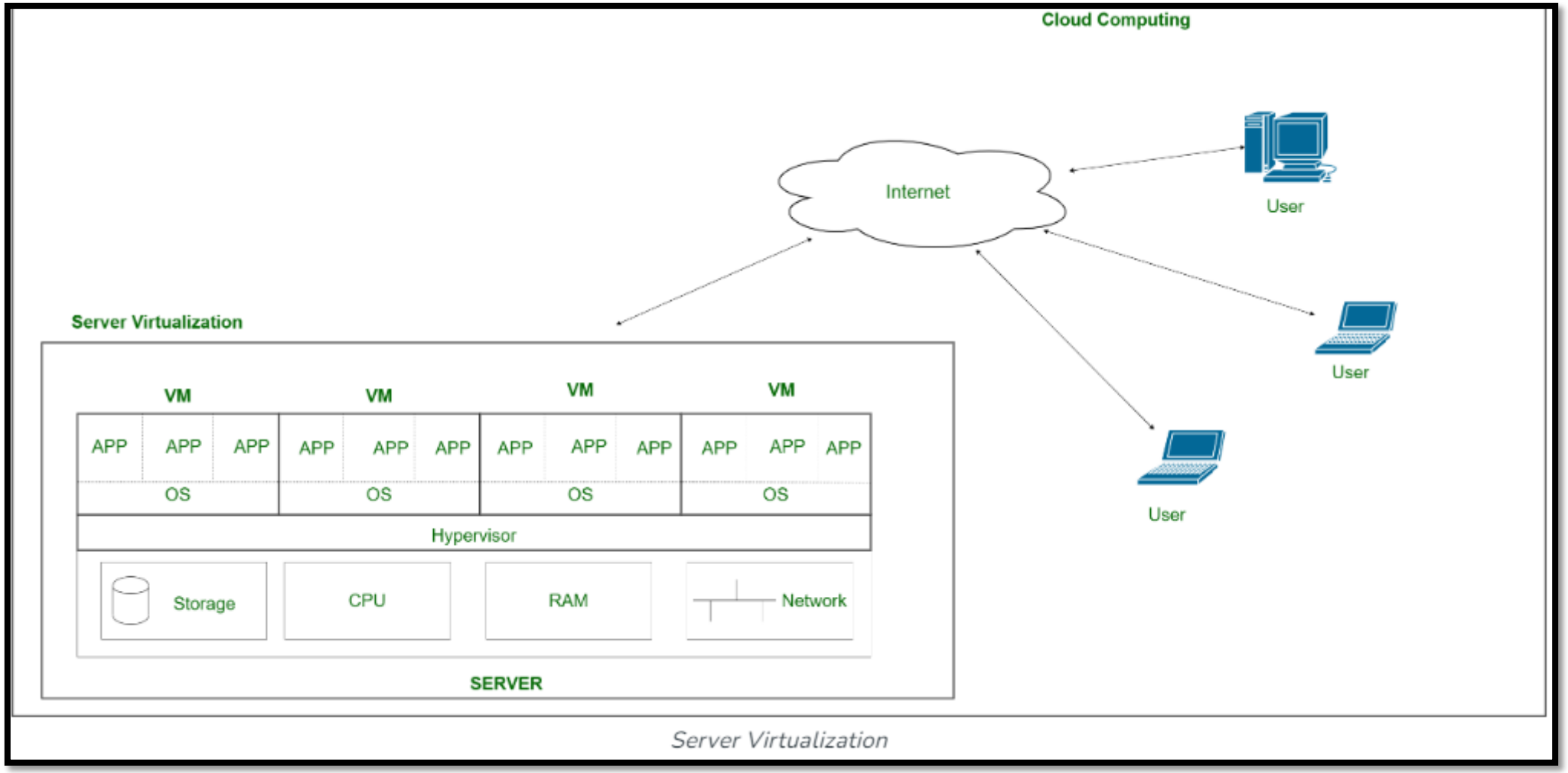
- **Storage Virtualization:-**
- Example: EMC ViPR, IBM Spectrum Virtualize, Storage Virtualization Appliances.
- IT administrators can streamline storage activities, such as archiving, backup, and recovery, because they can combine multiple network storage devices virtually into a single storage device.

Types of Virtualization

- **Server Virtualization:-**
- Server virtualization is a process that partitions a physical server into multiple virtual servers.
- It is an efficient and cost-effective way to use server resources and deploy IT services in an organization.
- Without server virtualization, physical servers use only a small amount of their processing capacities, which leave devices idle.
- This is a kind of virtualization in which the masking of server resources takes place. Here, the central server (physical server) is divided into multiple different virtual servers by changing the identity number, and processors.
- So, each system can operate its operating systems in an isolated manner. Where each sub-server knows the identity of the central server.
- It causes an increase in performance and reduces the operating cost by the deployment of main server resources into a sub-server resource.
- Example: VMware, Microsoft Hyper-V, KVM (Kernel-based Virtual Machine).

Types of Virtualization

- **Server Virtualization:-**



Types of Virtualization

- **Data Virtualization:-**
- Modern organizations collect data from several sources and store it in different formats. They might also store data in different places, such as in a cloud infrastructure and an on-premises data center.
- Data virtualization creates a software layer between this data and the applications that need it.
- Data virtualization tools process an application's data request and return results in a suitable format.
- Thus, organizations use data virtualization solutions to increase flexibility for data integration and support cross-functional data analysis.
- Data virtualization is a solution to the data management problem of analyzing data from different sources collectively and at a much faster pace.
- It enables organizations to centrally manage and alter data from several sources, such as excel files, google analytics reports, HubSpot reports, etc., while offering a holistic view (single view) of the data.

Types of Virtualization

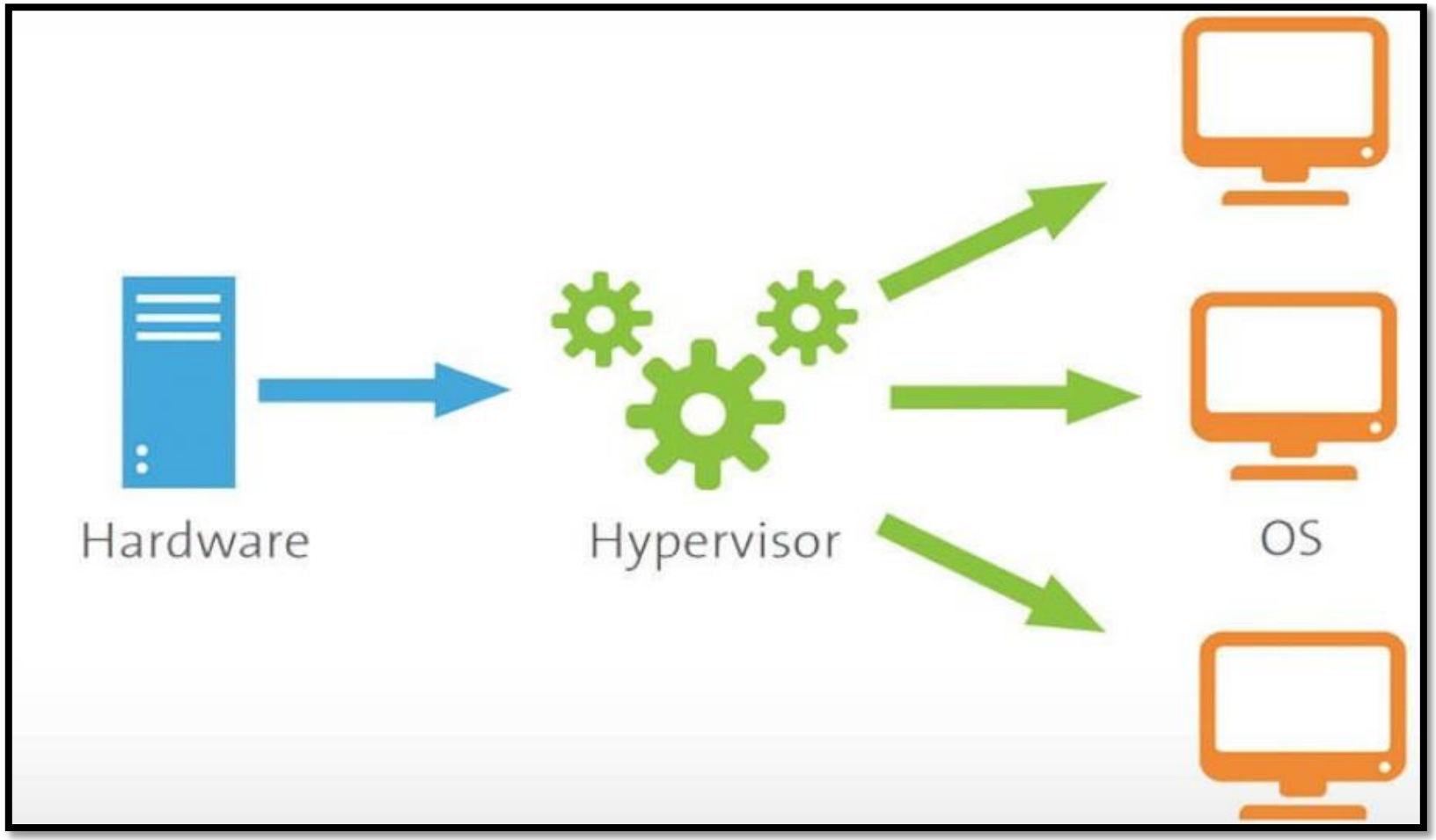
- **Data Virtualization:-**
- Data virtualization works by separating the collected data from its underlying data logic.
- A virtualization layer, called a data virtualization tool, acts as a mediator between the source and the front-end usage of the data.
- Virtualizing data enables users to collectively view heterogeneous data sets via a single interface as well as access the source of the collected data in real-time.
- Data virtualization is primarily used as a part of data integration in areas such as BI (business intelligence), Cloud computing and of course, data management.

Hypervisors and Virtual Machines

- **Introduction to Hypervisors:-**
- A hypervisor, also known as a virtual machine monitor or VMM.
- The hypervisor is a piece of software that allows us to build and run virtual machines which are abbreviated as VMs.
- A hypervisor allows a single host computer to support multiple virtual machines (VMs) by sharing resources including memory and processing.
- A hypervisor is a mandatory component that makes it possible for the virtual machine to run and is sometimes called a virtual machine monitor.
- A hypervisor's main job is to decouple the hardware powering the network from the operating system and other software running on the virtual machine.
- It isolates each virtual machine, allowing them to run separate operating systems simultaneously and protecting them from potential security issues.

Hypervisors and Virtual Machines

- **Introduction to Hypervisors:-**



Hypervisors and Virtual Machines

- **Use of Hypervisors:-**
- Hypervisor can be quickly switched between servers.
- Since a hypervisor with the help of its special feature, it allows several virtual machines to operate on a single physical server. So, it helps us to reduce The Space efficiency ,The Energy uses and The Maintenance requirements of the server.
- Hypervisors separate a system's operating system (OS) and resources from the physical machine.
- They organize these separated resources into files called virtual machines (VMs), hence the pseudonym virtual machine monitor.
- Then, they assign computing power, data, and storage to each one.
- A hypervisor prohibits these files from interfering with one another, thereby maintaining the system.
- The hypervisor keeps each virtual machine separate so that if one crashes or experiences a fatal error, the others continue to run without issue

Hypervisors and Virtual Machines

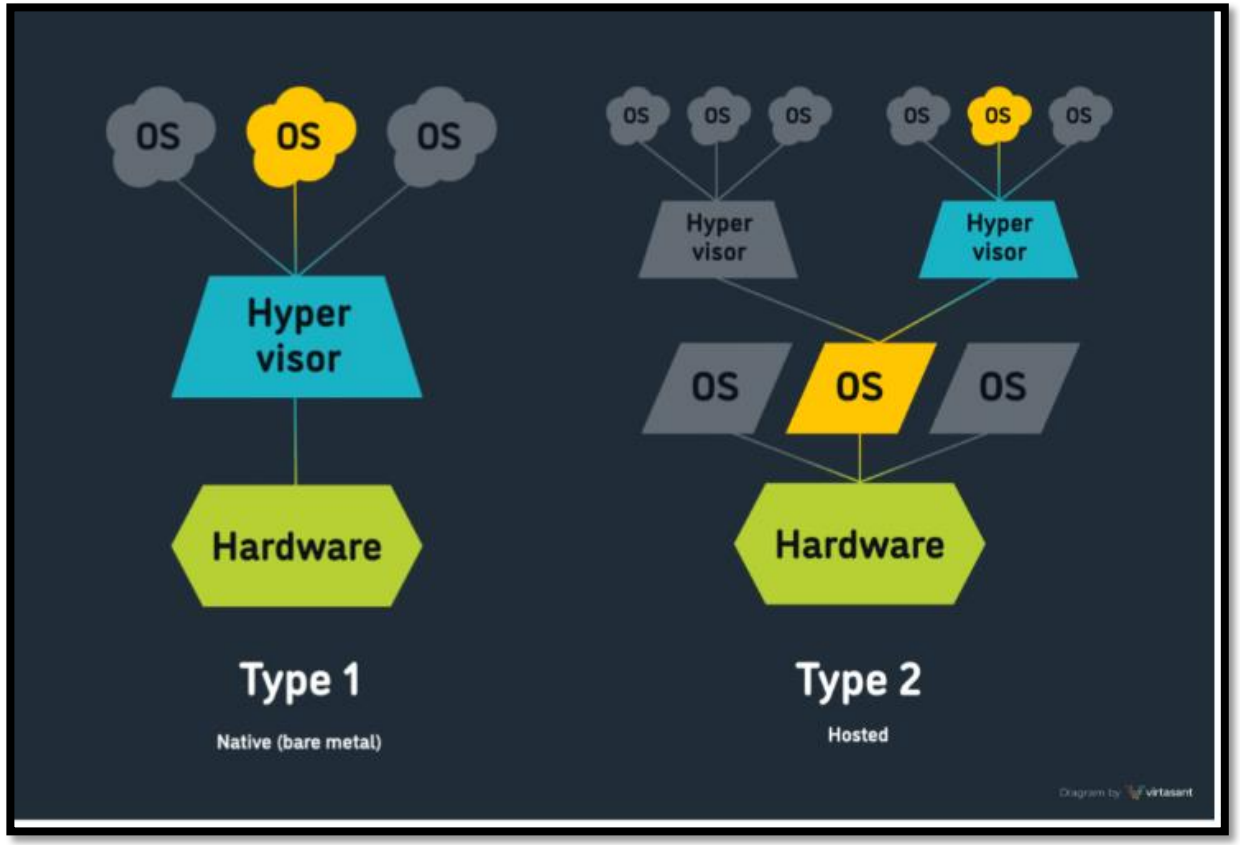
- **Working of Hypervisors:-**
- Hypervisors support the **creation and management of virtual machines (VMs)** by abstracting a computer's software from its hardware.
- By abstracting a computer's programme from its hardware, hypervisors enable the development and control of virtual machines (VMs).
- Hypervisors enable virtualization by converting requests between real and virtual resources.
- Instead of running across the OS and an application, hypervisors build a layer for virtualization that sits between the server hardware and the operating system.
- They separate the host machine, which houses the operating system and Programmes, from the virtual machines that utilize its resources.
- The hypervisor suggests a shared pool of resources, including a CPU, storage spaces and memory, which may be shared across guest virtual machines by hiding the real hardware components of the actual server from the divided virtual machines.

Hypervisors and Virtual Machines

- **Benefits of Hypervisors:-**
- **Efficiency:-** Hypervisors running several virtual machines make better use of available hardware resources. Using VMs is massively more cost-effective and uses less energy than running multiple physical servers.
- **Speed:-** Modern hypervisors can create and provision VMs almost instantly, the opposite of the time and effort it takes to Purchase, install, and provision a physical server.
- **Scalability:-** It is very easy to assign more resources to a VM, like memory, processor cores, or storage. Most modern hypervisors can easily scale VMs.
- **Flexibility:-** While traditional servers are harder to manage, VMs remain separate from the underlying hardware and are easy to migrate, backup, or clone.

Hypervisors and Virtual Machines

- Types of Hypervisors:-
- There are two types of hypervisors:
- Type 1(also known as "bare metal")
- Type 2(also known as "hosted").



Types of Hypervisors

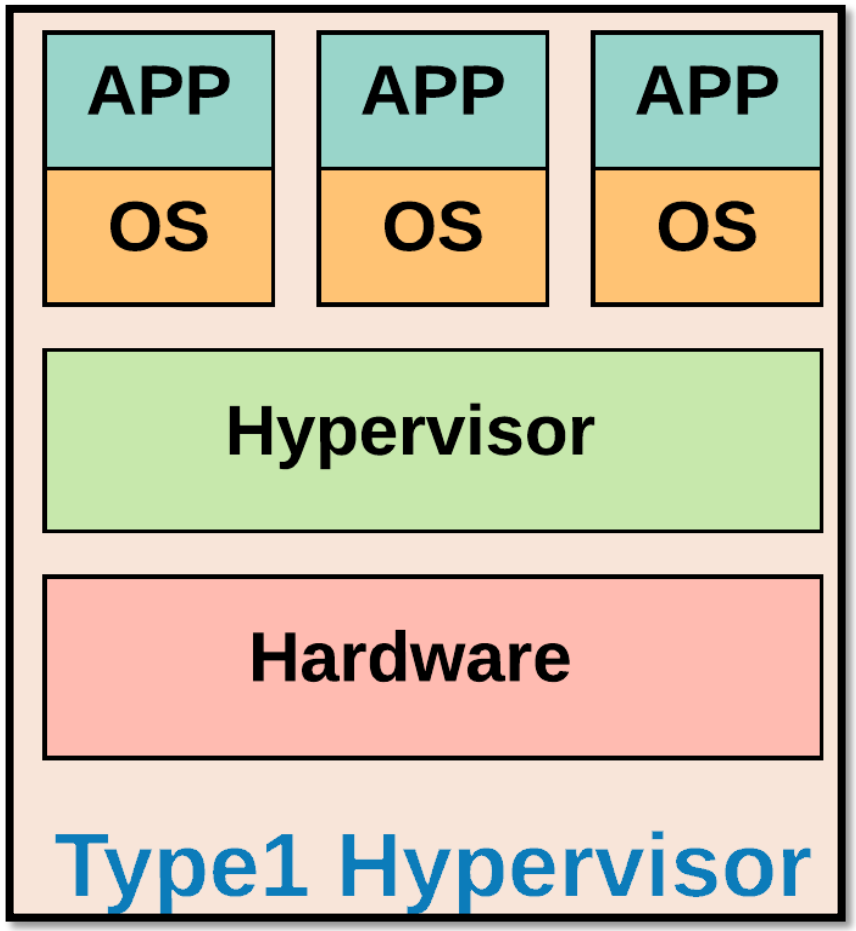
Type 1 Hypervisors:-

- A Type 1 hypervisor runs directly on a physical host. That's why it's also known as a **bare metal hypervisor.**
- Basically, you would install a Type 1 hypervisor before anything else on a physical host, so it sort of acts like that host's operating system.
- Consequently, a Type 1 hypervisor has direct access to the underlying physical host's resources—e.g., CPU, RAM, storage, and network interface.
- Type 1 hypervisor functions similarly to a minimal operating system running entirely on the host's hardware.
- A Type 1 hypervisor is often installed on a physical host first, so it behaves much like the host's operating system.
- This hypervisor is commonly seen in business data centers and other server-based systems. **Examples: VMware ESXi and Microsoft Hyper-V.**

Types of Hypervisors

- **Types of Hypervisors:-**

Type 1 Hypervisors:-



Types of Hypervisors

- **Advantages of Type 1 Hypervisors:-**
- **Generally faster than Type 2**:-This is because Type 1 hypervisors have direct access to the underlying physical host's resources such as CPU, RAM, storage, and network interfaces. For this reason, Type 1 hypervisors have lower latency compared to Type 2.
- **More resource-rich:-** A Type 1 hypervisor doesn't have to share the underlying resources with a host OS. Thus, it can access a greater amount of CPU, RAM, storage, and network bandwidth. This attribute also contributes to the performance of a Type 1 hypervisor.
- **More secure:-** Since a host OS doesn't exist in a Type 1 hypervisor deployment, that deployment's attack surface is much smaller than that of Type 2. In turn, this means threat actors will have substantially fewer vulnerabilities to exploit.
- **More stable:-**The absence of a host OS also eliminates host OS-related issues that may affect the performance and availability of the virtual machines running on top of the hypervisor.

Types of Hypervisors

- **Disadvantages of Type 1 Hypervisors:-**
- **Harder to set up and administer:-**With a Type 1 hypervisor, you must start from scratch, as you'll be dealing with a bare metal server.
- Even if you still need to install a host OS in a Type 2 deployment, IT administrators (even junior administrators) are more familiar with OS installation and configuration. Hence, they might find it more challenging to administer a Type 1.
- **Dependent on an external administrative interface:-** Normally, Type 1 hypervisors are managed through an external administrative interface. That means you'll need a separate system/computer to set up a Type 1 hypervisor.

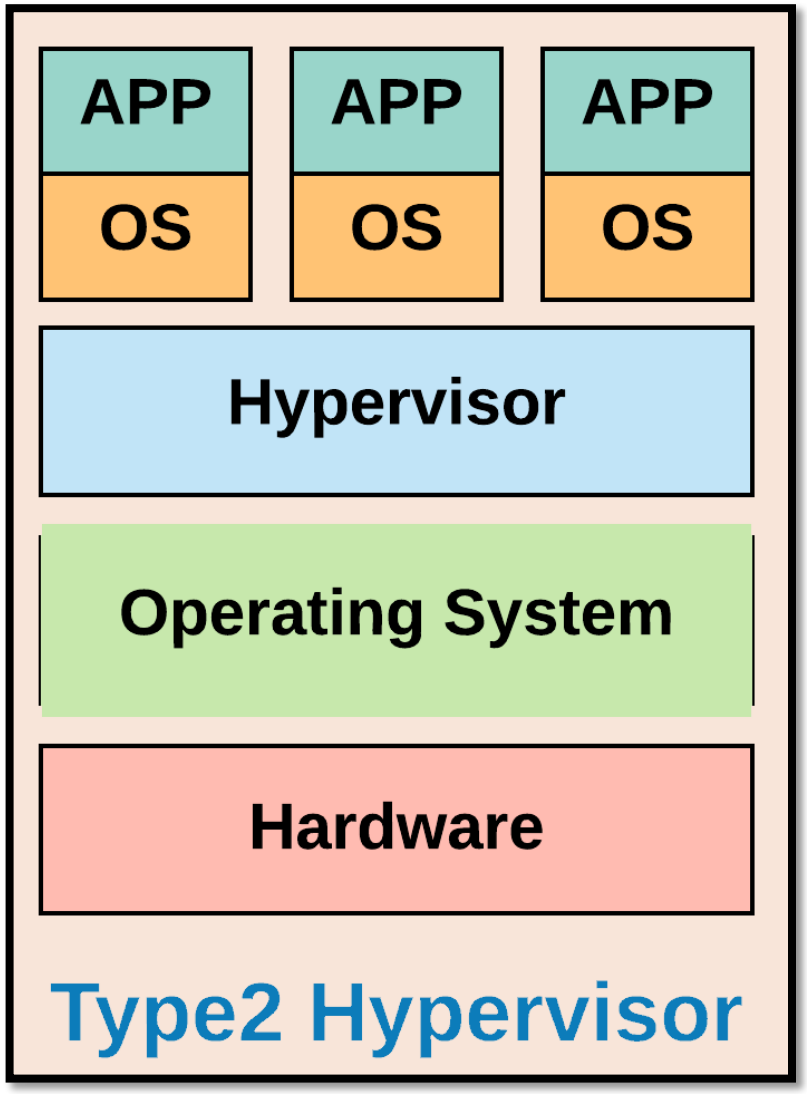
Types of Hypervisors

Type 2 Hypervisors:-

- A Type 2 hypervisor runs on top of a host OS. For this reason, it's also known as a **hosted hypervisor**. So, you would have to install a host OS on your physical host before you can install a Type 2 hypervisor.
- When a Type 2 hypervisor needs to communicate with the underlying hardware or access hardware resources, it must go through the host OS first.
- Type 2 hypervisors are often easy to configure and utilize. They are, therefore, more prevalent among end users.
- Individuals who want to run different operating systems on their machines are better suited for a type 2 hypervisor.
- A type 2 hypervisor, like other computer Programmes, works as a software layer on top of an operating system.
- **Virtual Box and Parallels® Desktop**, the most popular solution for running Windows on Macs, are Type 2 hypervisors.

Types of Hypervisors

Type 2 Hypervisors:-



Types of Hypervisors

- **Advantages of Type 2 Hypervisors:-**
- **More affordable:-** The superior capabilities of Type 1 hypervisors from reliability, security, and efficiency standpoint come at a cost.
- They're naturally more expensive. Conversely, Type 2 hypervisors are more affordable. That's why, although they can theoretically be used in enterprise use cases, the target market of Type 2 hypervisors is normally end users.
- **Easier to install and manage:-** Affordability isn't the only reason why Type 2 hypervisors are more suitable for end users.
- Type 2 hypervisors are also usually easier to use. Hence, they're more appropriate for the less technical crowd.
- **Hardware-agnostic:-** modern Type-2 hypervisors can run on any hardware, which is supported by the host OS.

Types of Hypervisors

- **Disadvantages of Type 2 Hypervisors:-**
- **Slower than Type 1:-** Having a layer, the host OS, between a Type 2 hypervisor and the underlying physical host adds latency. Hence, Type 2 hypervisors are generally slower than their Type 1 counterparts.
- **Not as host-resource accessible:-** Since a Type 2 hypervisor shares CPU, RAM, storage, and network bandwidth from the underlying physical infrastructure with a host OS, the amount of resources a Type 2 hypervisor has access to is limited compared to that of a Type 1.
- **Less secure:-** The presence of a host OS increases the attack surface of the entire system. This means threat actors have more vulnerabilities to exploit.
- **Less stable:-** Any performance and availability issues in the host OS certainly affect the Type 2 hypervisor, and its VMs, running on top of it.

Types of Hypervisors

	Type 1 hypervisor	Type 2 hypervisor
Also known as	Bare metal hypervisor.	Hosted hypervisor.
Runs on	Underlying physical host machine hardware.	Underlying operating system (host OS).
Best suited for	Large, resource-intensive, or fixed-use workloads.	Desktop and development environments.
Can it negotiate dedicated resources?	Yes.	No.
Knowledge required	System administrator-level knowledge.	Basic user knowledge.
Examples	VMware ESXi, Microsoft Hyper-V, KVM.	Oracle VM VirtualBox, VMware Workstation, Microsoft Virtual PC.

Creating and Managing Virtual Machine

- **Creating a Virtual Machine with VirtualBox:-**

Step 1: Install Virtual Box

- Download and install Virtual Box from the official website: Virtual Box Downloads.

Step 2: Open Virtual Box and Create a New Virtual Machine

- Open Virtual Box.
- Click on the "New" button in the toolbar.
- Enter a name for your VM, select the type of operating system, and choose the version. Click "Next."

Step 3: Allocate Memory (RAM)

- Choose the amount of RAM to allocate for your VM. It's recommended to allocate at least 2 GB for most operating systems. Click "Next."

Creating and Managing Virtual Machine

- **Creating a Virtual Machine with Virtual Box:-**

Step 4: Create a Virtual Hard Disk

- Choose "Create a virtual hard disk now" and click "Create."
- Select the hard disk file type (usually VDI) and click "Next."
- Choose between a dynamically allocated or fixed-size hard disk. Dynamic allocation is recommended for flexibility. Click "Next."
- Specify the size of the hard disk. The recommended size varies based on the operating system you plan to install. Click "Create.“

Creating and Managing Virtual Machine

- **Creating a Virtual Machine with Virtual Box:-**

Step 5: Attach an Operating System Installation ISO

- With the VM selected, click "Settings."
- In the settings window, go to "System" and move the optical drive to the top in the "Boot Order" tab.
- Go to "Storage" and click on the empty disk under "Controller: IDE." On the right, click the disk icon next to "Optical Drive," then choose the installation ISO.

Step 6: Start the Virtual Machine

- Click "Start" with the VM selected.
- Follow the on-screen instructions to install the operating system on the virtual machine.

Creating and Managing Virtual Machine

- **Managing a Virtual Machine in Virtual Box:-**

Step 1: Power On/Off the VM

- To start the VM, select it and click "Start" or double-click on it.
- To shut down the VM, use the operating system's shutdown options or click the "Close" button in the Virtual Box window.

Step 2: Adjust VM Settings

- With the VM powered off, select it and click "Settings."
- Adjust settings such as RAM, CPU, and storage.

Step 3: Snapshots (Optional)

- With the VM powered off, select it and click "Snapshots."
- Click "Take" to create a snapshot. Snapshots are useful for saving the VM's state at a specific point.

Creating and Managing Virtual Machine

- **Managing a Virtual Machine in Virtual Box:-**

Step 4: Clone VM (Optional)

- With the VM powered off, select it and click "Clone."
- Follow the wizard to create a copy of the VM.

Step 5: Remove/Delete VM

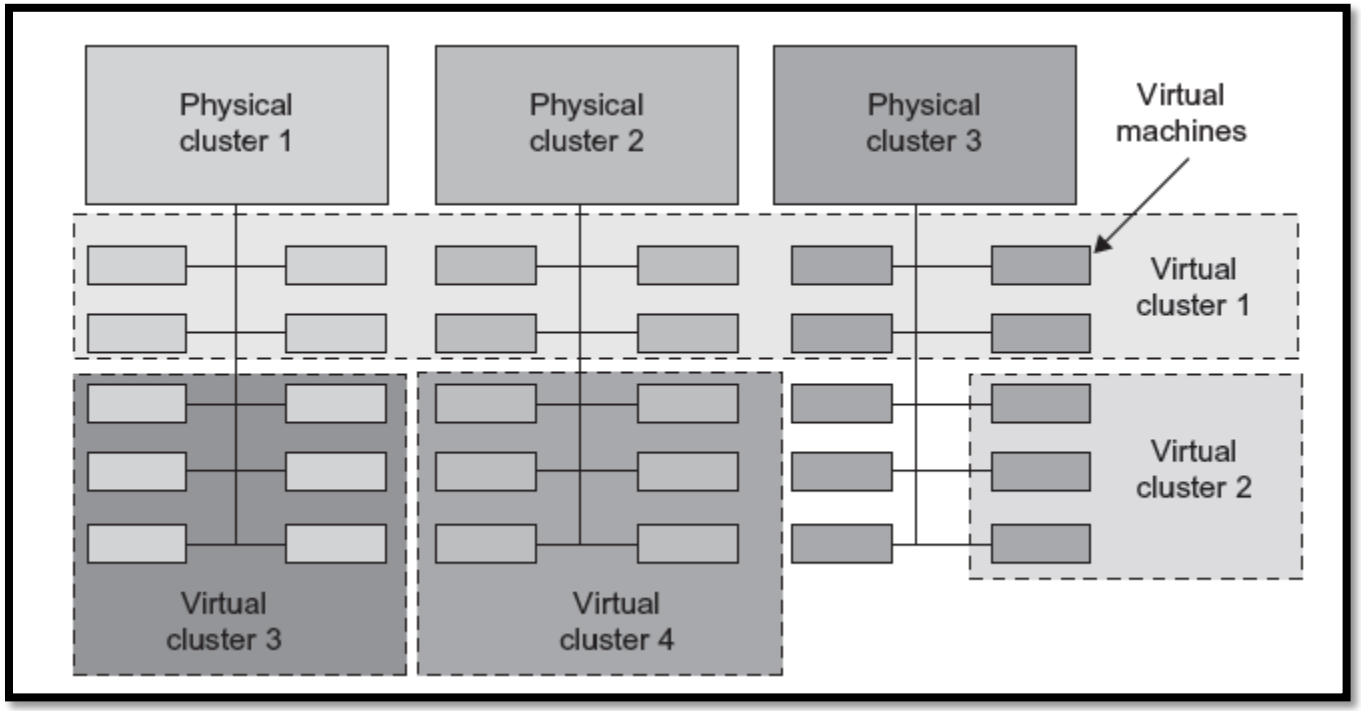
- With the VM powered off, select it and click "Remove."
- Choose to either delete the VM only from the list or delete all files.

Virtualization of Clusters and data centers automation

- **Virtualization of clusters:-**
- Virtualization of clusters involves creating virtual instances or representations of clustered resources such as servers, storage, or networks.
- This process allows multiple virtual machines (VMs) or containers to run on a single physical cluster, providing several benefits in terms of resource utilization, flexibility, and manageability.
- Virtual clusters are built with VMs installed at distributed servers from one or more physical clusters.
- The VMs in a virtual cluster are interconnected logically by a virtual network across several physical networks.
- Each virtual cluster is formed with physical machines or a VM hosted by multiple physical clusters.

Virtualization of Clusters and data centers automation

- **Virtualization of clusters:-**



Virtualization of Clusters and data centers automation

- **Virtualization of clusters:-**
- The provisioning of VMs to a virtual cluster is done dynamically to have the following interesting properties:
- The virtual cluster nodes can be either physical or virtual machines. Multiple VMs running with different OSes can be deployed on the same physical node.
- A VM runs with a guest OS, which is often different from the host OS, that manages the resources in the physical machine, where the VM is implemented.
- The size (number of nodes) of a virtual cluster can grow or shrink dynamically, similar to the way an overlay network varies in size in a peer-to-peer (P2P) network.
- The failure of any physical nodes may disable some VMs installed on the failing nodes. But the failure of VMs will not pull down the host system.

Virtualization of Clusters and data centers automation

- **Advantages of Virtualization of clusters:-**
- **Resource Consolidation:** Virtualization allows multiple VMs to share the resources of a single physical server, leading to better utilization of hardware.
- **Isolation:** Each VM operates in its isolated environment, ensuring that issues in one VM do not affect others, providing enhanced security and stability.
- **Flexibility and Scalability:** Virtualization enables quick provisioning and scaling of VMs, allowing clusters to adapt to changing workloads.
- **Hardware Independence**: VMs are decoupled from the underlying hardware, making it easier to migrate VMs between different physical servers within the cluster.

Virtualization of Clusters and data centers automation

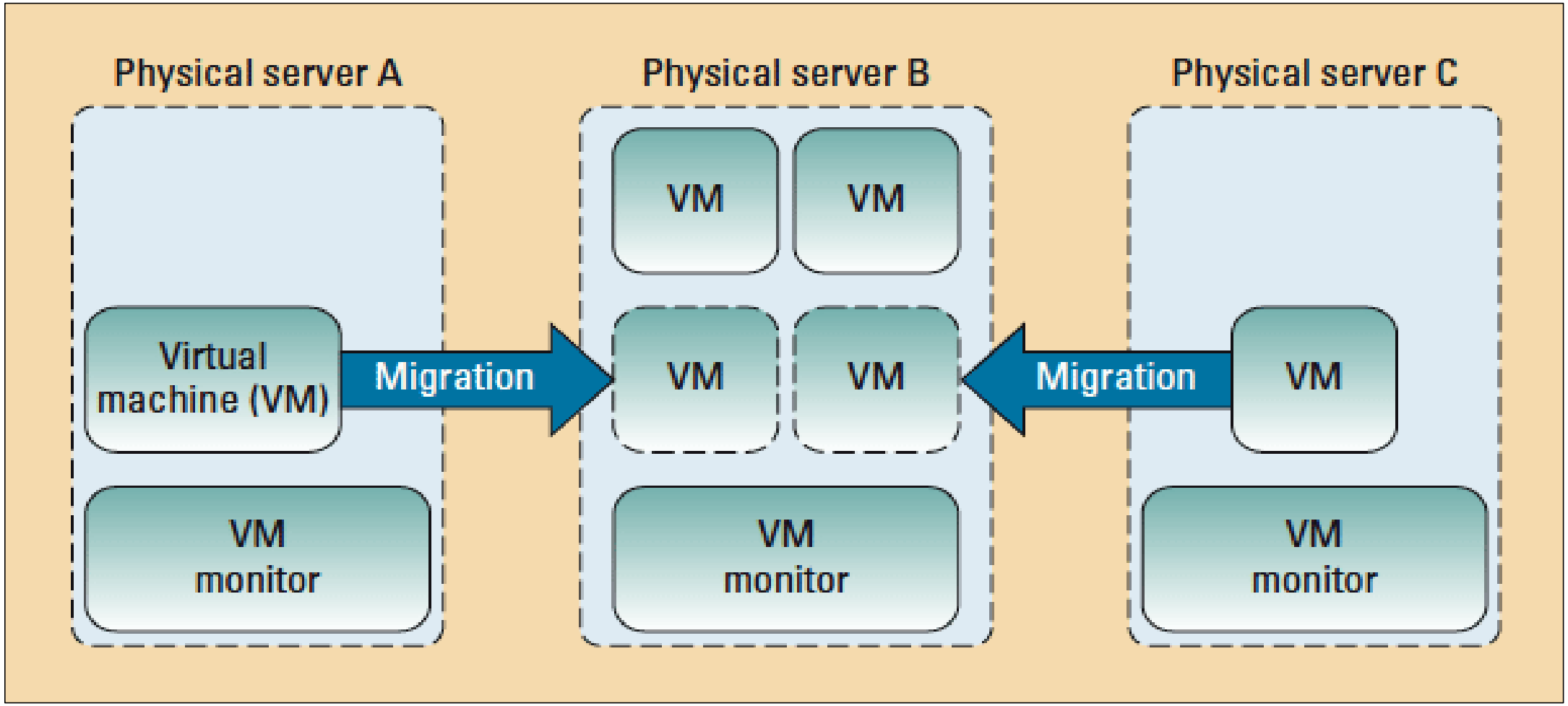
- **Virtualization of data center automation:-**
- Data centers have grown rapidly in recent years.
- Data-center automation means that huge volumes of hardware, software, and database resources in these data centers can be allocated dynamically to millions of Internet users simultaneously, with guaranteed QoS and cost-effectiveness.
- This automation process is triggered by the growth of virtualization products and cloud computing services.
- Virtualization is moving towards enhancing mobility, reducing planned downtime (for maintenance), and increasing the number of virtual clients.
- The latest virtualization development highlights high availability (HA), backup services, workload balancing, utility computing, production consolidation and further increases in client bases.
- Mainly two things can be done for virtualization of data center automation: **Server Consolidation in Data Centers and Virtual Storage Management.**

Virtualization of data centers automation

- **Server Consolidation in Data Centers :-**
- In data centers, a large number of heterogeneous workloads can run on servers at various times.
- These heterogeneous workloads can be roughly divided into two categories:
- chatty workloads and non interactive workloads.
- Chatty workloads may burst at some point and return to a silent state at some other point.
- Non interactive workloads do not require people's efforts to make progress after they are submitted.
- At various stages, the requirements for resources of these workloads are dramatically different.
- However, to guarantee that a workload will always be able to cope with all demand levels, the workload is statically allocated enough resources so that peak demand is satisfied. (resource optimization is focused on the CPU, memory, and network interfaces).
- Therefore, it is common that most servers in data centers are **underutilized**.
- A large amount of hardware, space, power, and management cost of these servers is wasted.

Virtualization of data centers automation

- **Server Consolidation in Data Centers :-**



Virtualization of data centers automation

- **Server Consolidation in Data Centers :-**
- Virtualization-based Server consolidation is an approach to improve the low utility ratio of hardware resources by reducing the number of physical servers.
- Data centers need to optimize their resource management.
- Server virtualization enables smaller resource allocation than a physical machine.
- In general, the use of VMs increases resource management complexity.
- This causes a challenge in terms of how to improve resource utilization as well as guarantee QoS in data centers.

Virtualization of data centers automation

- **Advantages of Server Consolidation in Data Centers :-**
- Consolidation enhances hardware utilization. Many underutilized servers are consolidated into fewer servers to enhance resource utilization. Consolidation also facilitates backup services and disaster recovery.
- This approach enables more agile provisioning and deployment of resources. In a virtual environment, the images of the guest OS and their applications are readily cloned and reused.
- The total cost of ownership is reduced. In this sense, server virtualization causes deferred purchases of new servers, a smaller data-center footprint, lower maintenance costs, and lower power, cooling, and cabling requirements.
- This approach improves availability and business continuity. The crash of a guest OS has no effect on the host OS or any other guest OS. It becomes easier to transfer a VM from one server to another, because virtual servers are unaware of the underlying hardware.

Virtualization of data centers automation

- **Virtual storage management:-**
- Virtual storage includes the storage managed by VMMs and guest OSes.
- Generally, the data stored in this environment can be classified into two categories:
- **VM images and Application data.**
- The VM images are special to the virtual environment, while application data includes all other data which is the same as the data in traditional OS environments.
- The most important aspects of system virtualization are encapsulation and isolation.
- Traditional operating systems and applications running on them can be encapsulated in VMs.
- Only one operating system runs in a virtualization – while many applications run in the operating system.
- System virtualization allows multiple VMs to run on a physical machine and the VMs are completely isolated.

Virtualization of data centers automation

- **Virtual storage management:-**
- However – In virtualization environments, a virtualization layer is inserted between the hardware and traditional operating systems or a traditional operating system is modified to support virtualization.
- This procedure complicates storage operations.
- On the one hand, storage management of the guest OS performs as though it is operating in a real hard disk while the guest OSes cannot access the hard disk directly.
- On the other hand, many guest OSes contest the hard disk when many VMs are running on a single physical machine.
- Therefore, storage management of the underlying VMM is much more complex than that of guest OSes (traditional OSes).
- In data centers, there are often thousands of VMs, which cause the VM images to become flooded.
- Many researchers tried to solve these problems in virtual storage management.
- The main purposes of their research are to make management easy while enhancing performance and reducing the amount of storage occupied by the VM images.