BIT4440

CLOUD COMPUTING AND BIG DATA

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Cloud Computing and Big Data

- Introduction
- Cloud Computing Technologies
- Big Data Technologies
- Data Management in the Cloud
- Big Data Analytics in the Cloud
- Virtualization for Cloud
- Cloud Security
- Cloud Application Development Tools and Frameworks
- Cloud Application Development
- Cloud Deployment and Management
- Cloud Project Development

Virtualization for Cloud

Introduction

- Virtualization is a technology **that helps us to install different Operating Systems on hardware**.
- Virtualization is **the process of creating a virtual representation of physical resources such as servers, storage, and networks**.
- It allows **multiple virtual instances to run on a single physical machine or infrastructure**.
- Virtualization abstracts hardware resources from the underlying physical infrastructure.

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Definition

- Virtualization in cloud computing refers to the abstraction of physical computing resources into virtual instances that can be easily provisioned, managed, and scaled on-demand.
- Physical computing resources may include:
  - ✓Servers, storage, and networks, operating system or desktop

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Importance of Virtualization

- Virtualization plays a pivotal role in cloud computing:
- **Resource Efficiency**: Virtualization enables efficient resource utilization by allowing multiple virtual machines (VMs) or containers to share physical resources, reducing resource wastage.
- **Isolation**: Virtualization ensures isolation between VMs or containers, preventing one from affecting the others, which is crucial for security and stability.

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Importance of Virtualization

- **Scalability**: Virtualization facilitates easy scalability by adding or removing virtual instances based on demand, making cloud infrastructure highly adaptable.
- **Cost Savings**: Virtualization reduces hardware procurement costs, as you can get more out of existing infrastructure.
- **Migration and Disaster Recovery**: Virtualization simplifies migration and disaster recovery processes by encapsulating entire VMs for easy transport and backup.

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Virtualization Technologies

- Three fundamental virtualization technologies: **Virtual Machines (VMs), Hypervisors, and Containers**.
- Virtual Machines (VMs):
  - ✓VMs are complete virtualized computing environments **that mimic physical hardware, including a virtual CPU, RAM, storage, and network interfaces**.
  - ✓Each VM runs its own full-fledged operating system.

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Virtualization Technologies

- Hypervisors:
  - ✓Also known as Virtual Machine Manager or Virtual Machine Monitor (VMM).
  - ✓Hypervisors are software or hardware-based virtualization platforms that manage and run VMs.
  - ✓They sit between the physical hardware and VMs, allocating resources and ensuring isolation.
  - ✓There two types of hypervisors

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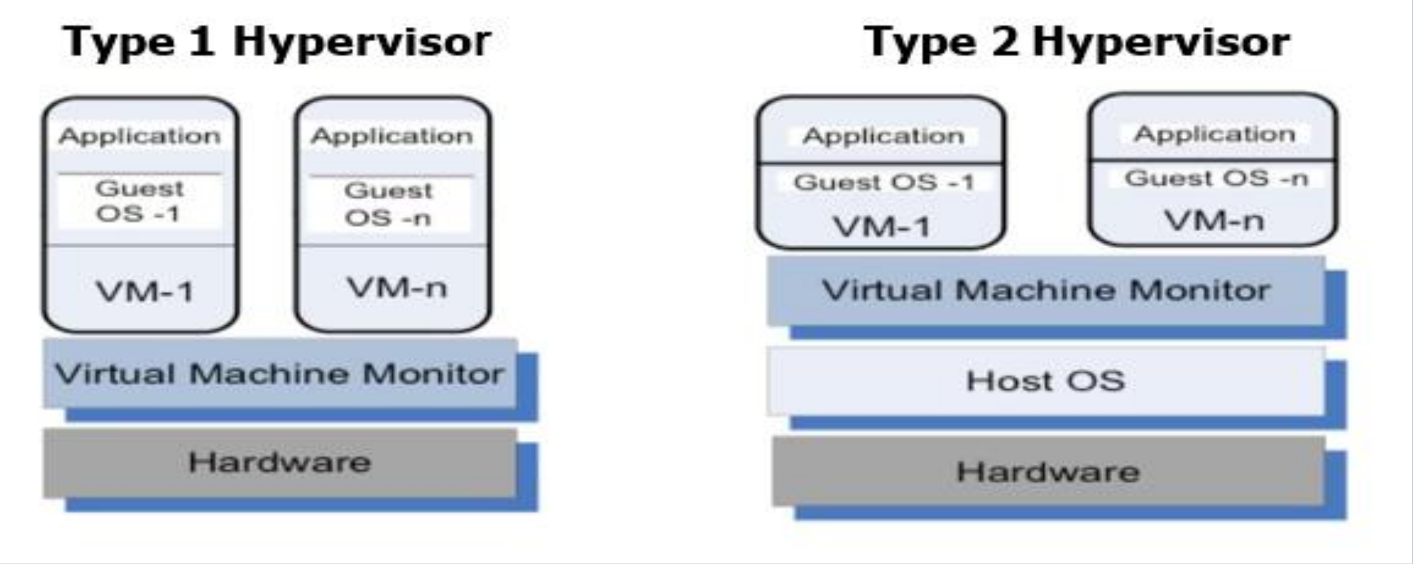
Virtualization Technologies



- **Taxonomy of VMMs:**
  1. Type 1 Hypervisor (**bare metal, native**): supports multiple virtual machines and runs directly on the hardware (e.g., VMware ESX , Xen, Denali)
  2. Type 2 Hypervisor (**hosted**) VM - runs under a host operating system (e.g., user-mode Linux)

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Virtualization Technologies

- Containers:
  - ✓Containers are lightweight, portable, and isolated application environments that share the host OS kernel.
  - ✓They package an application and its dependencies into a single unit, making it easy to deploy and manage.

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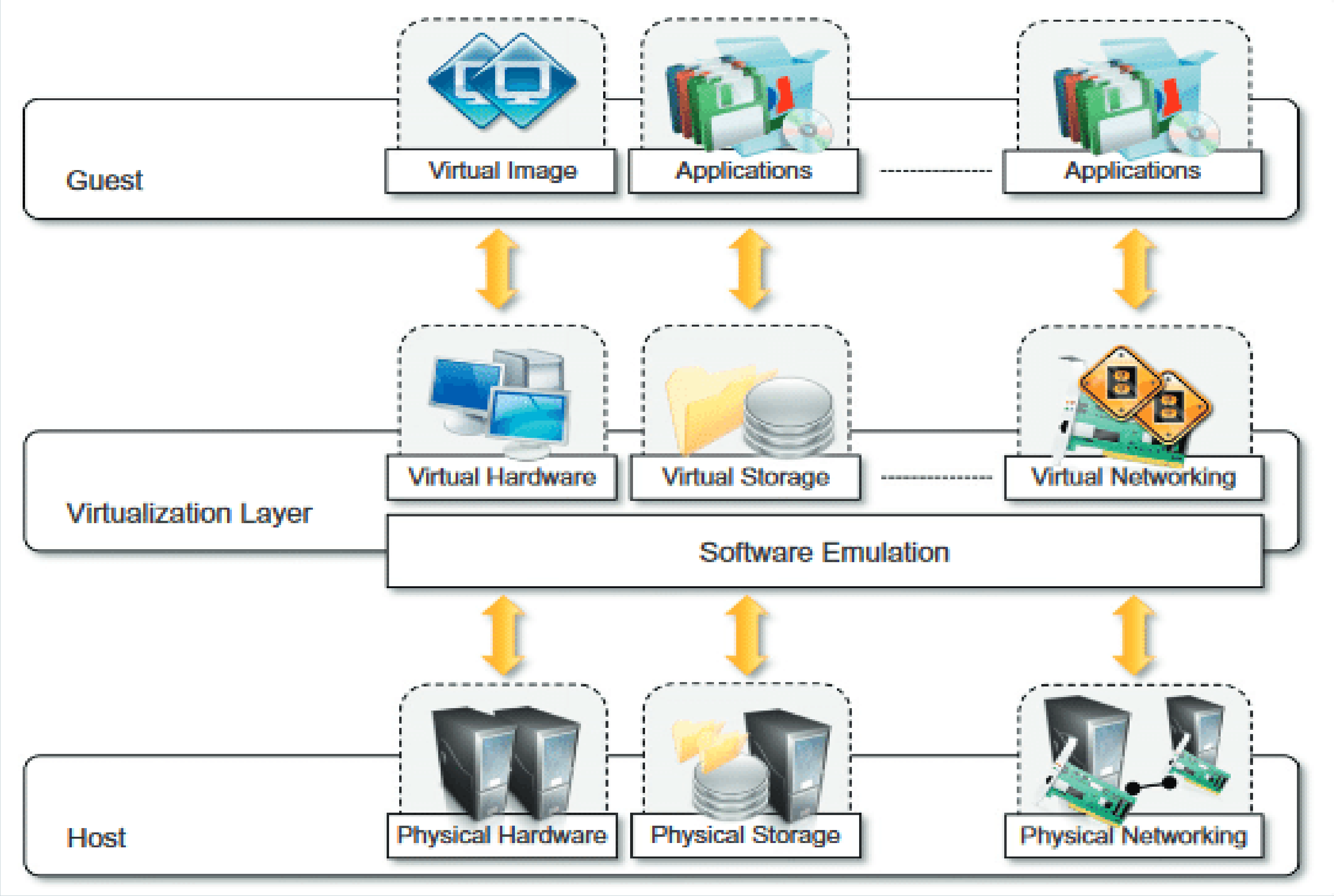
Virtualization Reference Model



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Virtualization Reference Model

Guest

- The guest represents **the system component that interacts with the virtualization layer** rather than with the host, as would normally happen.
- Guests usually **consist of one or more virtual disk files, and a VM definition file**.
- Virtual Machines are centrally **managed by a host application that sees and manages each virtual machine as a different application.**

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Virtualization Reference Model

Virtualization Layer

- The virtualization layer is responsible **for recreating the same or a different environment where the guest will operate.**
- It is an additional abstraction layer between a network and storage hardware, **computing, and the application running on it.**
- Usually it helps to **run a single operating system per machine which can be very inflexible compared to the usage of virtualization**.

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Virtualization Reference Model

Host

- The host represents the **original environment where the guest is supposed to be managed**.
- Each guest runs on the host using shared resources donated to it by the host.
- The operating system, **works as the host and manages the physical resource management, and the device support.**

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Virtualization Approaches

- **Full-Virtualization**
  - ✓Full-virtualization works with unmodified guest operating systems.
  - ✓It doesn't require any modifications to the guest OS.
- **Use Cases:**
  - ✓Full-virtualization is suitable when you need to run **a variety of guest operating systems**, including legacy and proprietary ones, without modification.
  - ✓It is commonly used in **desktop virtualization, server virtualization, and cloud computing environments**.

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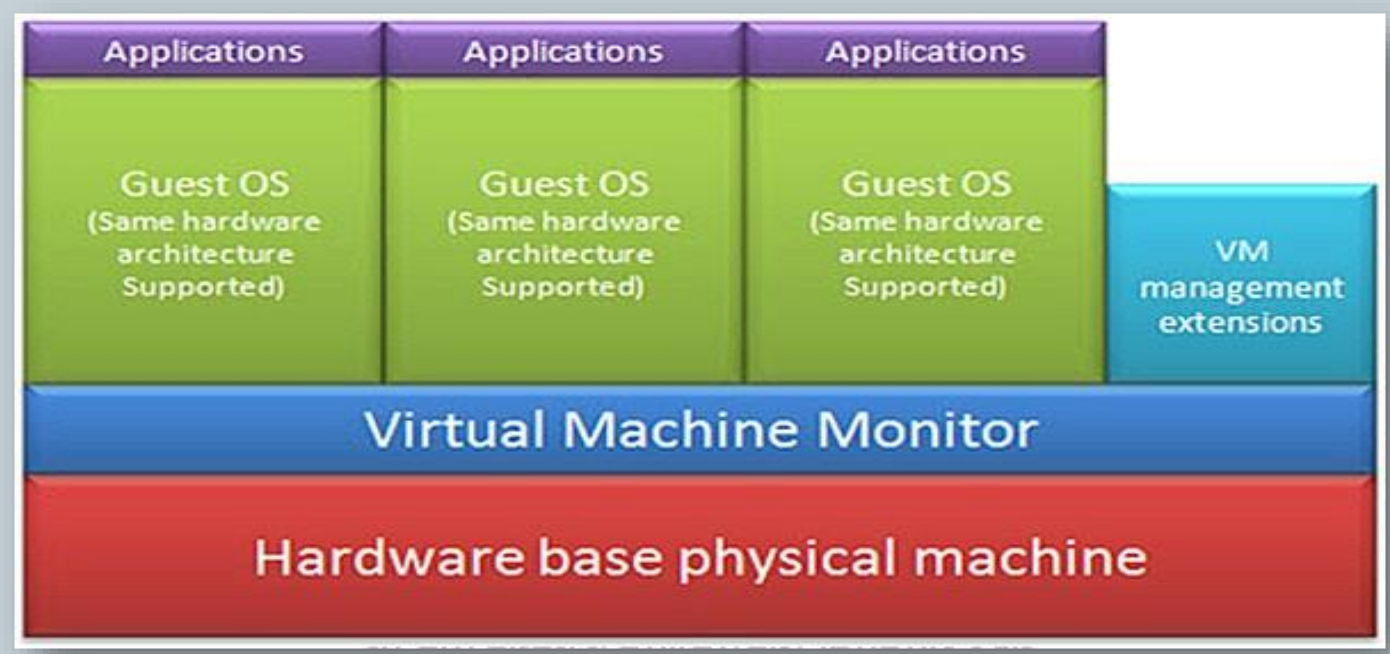
Virtualization Approaches

- Full-Virtualization



Pros	**Need not to modify guest OS**
Cons	**Significant performance hit**

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Virtualization Approaches

- **Para-Virtualization**
  - ✓In para-virtualization, the guest OS is modified to interact with the hypervisor using special API calls.
- Use Cases:
  - ✓Para-virtualization is suitable **when you have control over the guest OS and can modify it** to improve virtualization performance.
  - ✓It is commonly used in scenarios where performance is a critical factor, such as **high-performance computing (HPC) clusters and data centers**.

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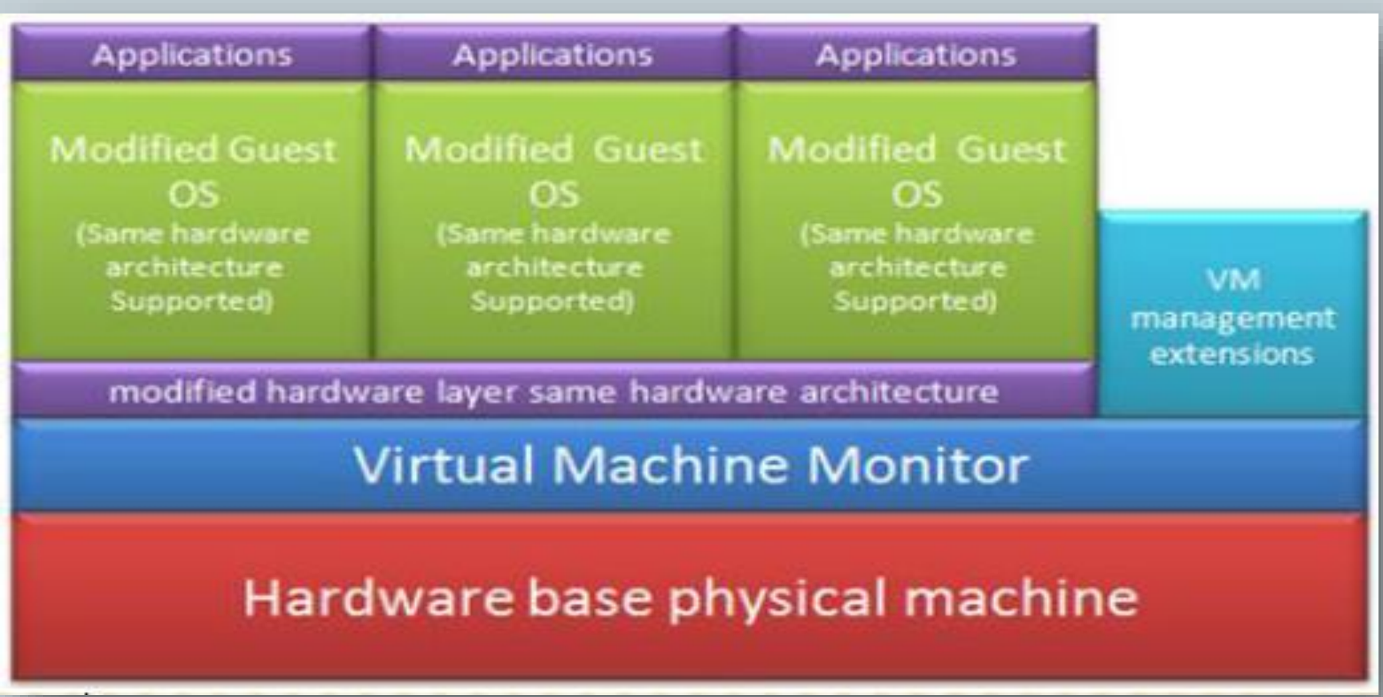
Virtualization Approaches

- Para-Virtualization



Pros	**Light weight and high performance**
Cons	**Require modification of guest OS**

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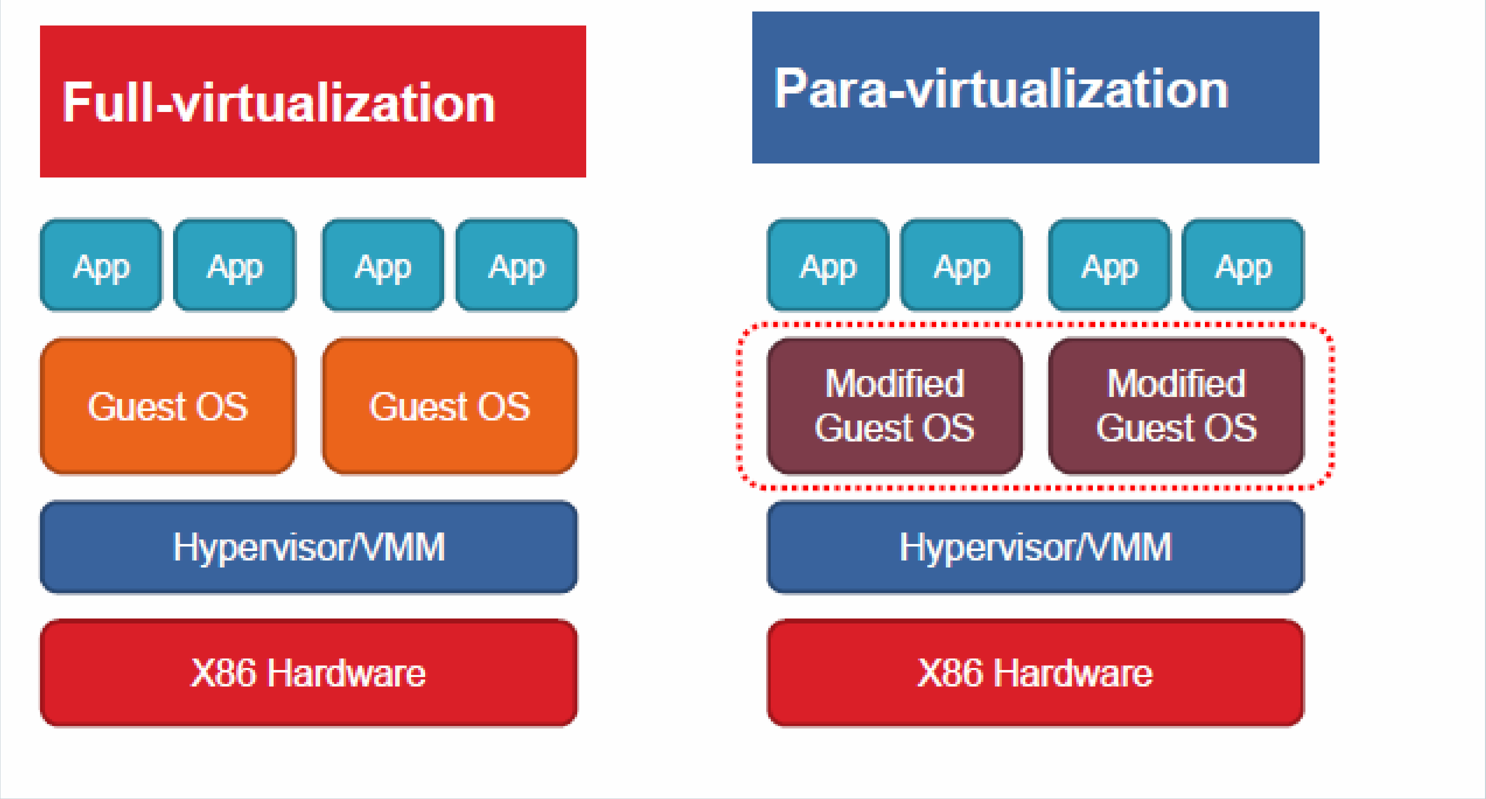
Virtualization Approaches

- Full-Virtualization Vs Para-Virtualization



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Types of Virtual Machine

- The two main types are ***System and Process Virtual Machines.***
- **System VMs** emulate an entire physical computer, providing a complete operating system environment and virtualized hardware to run multiple guest operating systems concurrently.
- A System Virtual Machine is also known as **Hardware Virtual Machine** or full virtualization

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Types of Virtual Machine

- Examples of System VMs software - **VMware, VirtualBox, Windows Virtual PC, Parallels, QEMU, Citrix Xen.**
- Use Cases:
  - ✓ They are commonly used in **data centers and cloud computing environments** for server consolidation, workload isolation, and running multiple operating systems on the same physical server.

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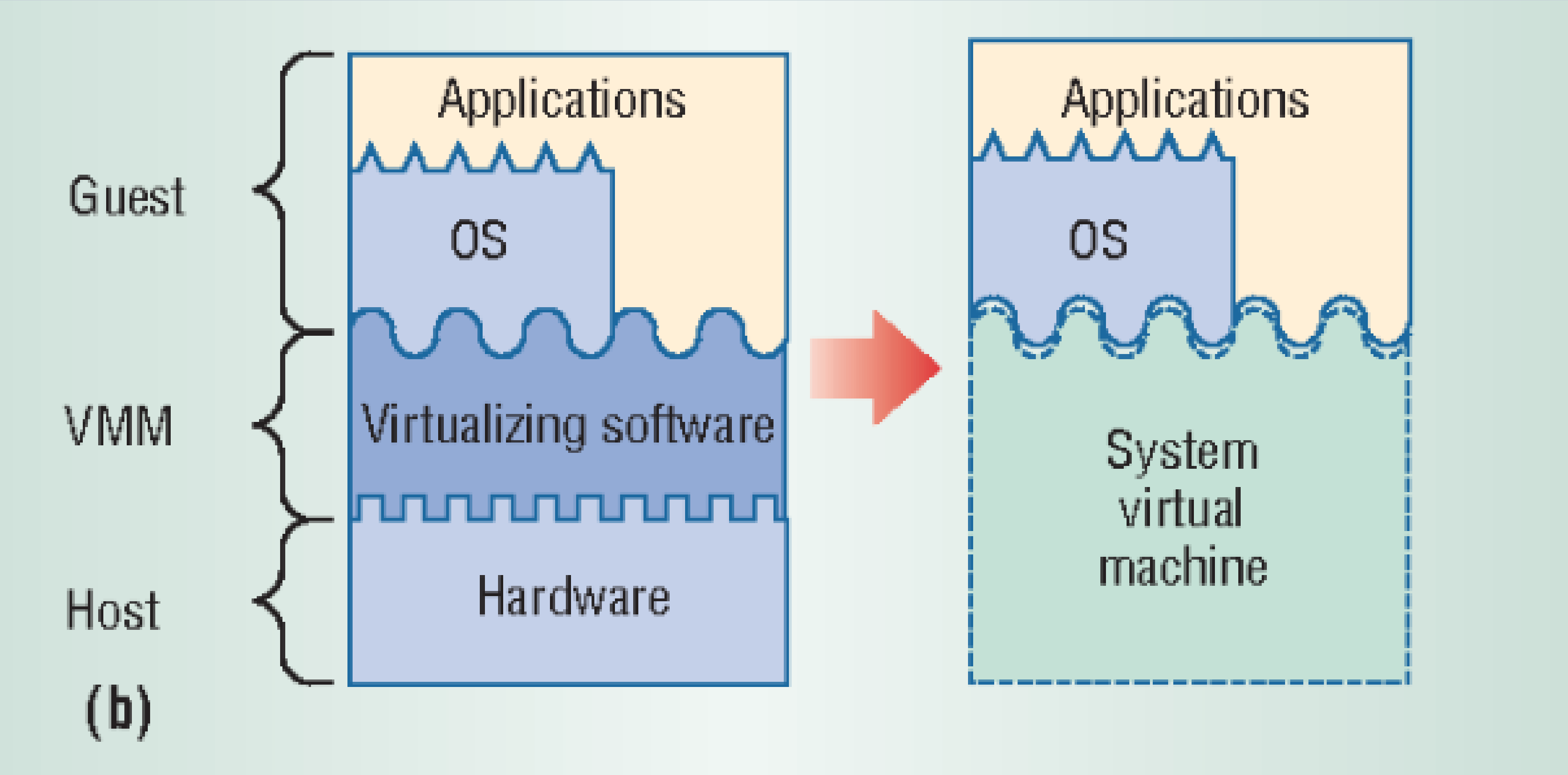
Types of Virtual Machine

System Virtual Machine



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Types of Virtual Machine

- **Process VMs** are designed to run individual processes or applications in an isolated environment, rather than emulating an entire operating system.
- A Process Virtual Machine **is also called a Language Virtual Machine or an Application Virtual Machine or Managed Runtime Environment**.

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Types of Virtual Machine

- Process virtual machines **are implemented using an interpreter**;
- For improving performance **these virtual machines will use just-in-time compilers internally**.
- Examples of Process VMs –
  - ✓**Parrot Virtual Machine**: It is a process VM designed to support multiple high-level programming languages.

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Types of Virtual Machine

- Examples of Process VMs –
  - ✓**Parrot Virtual Machine**: It is a process VM designed to support multiple high-level programming languages.
  - ✓**QEMU**: It is a process VM that can emulate different hardware platforms and run various operating systems.
  - ✓**Wine**: It is a process VM that allows running Windows applications on Linux and other Unix-like operating systems.

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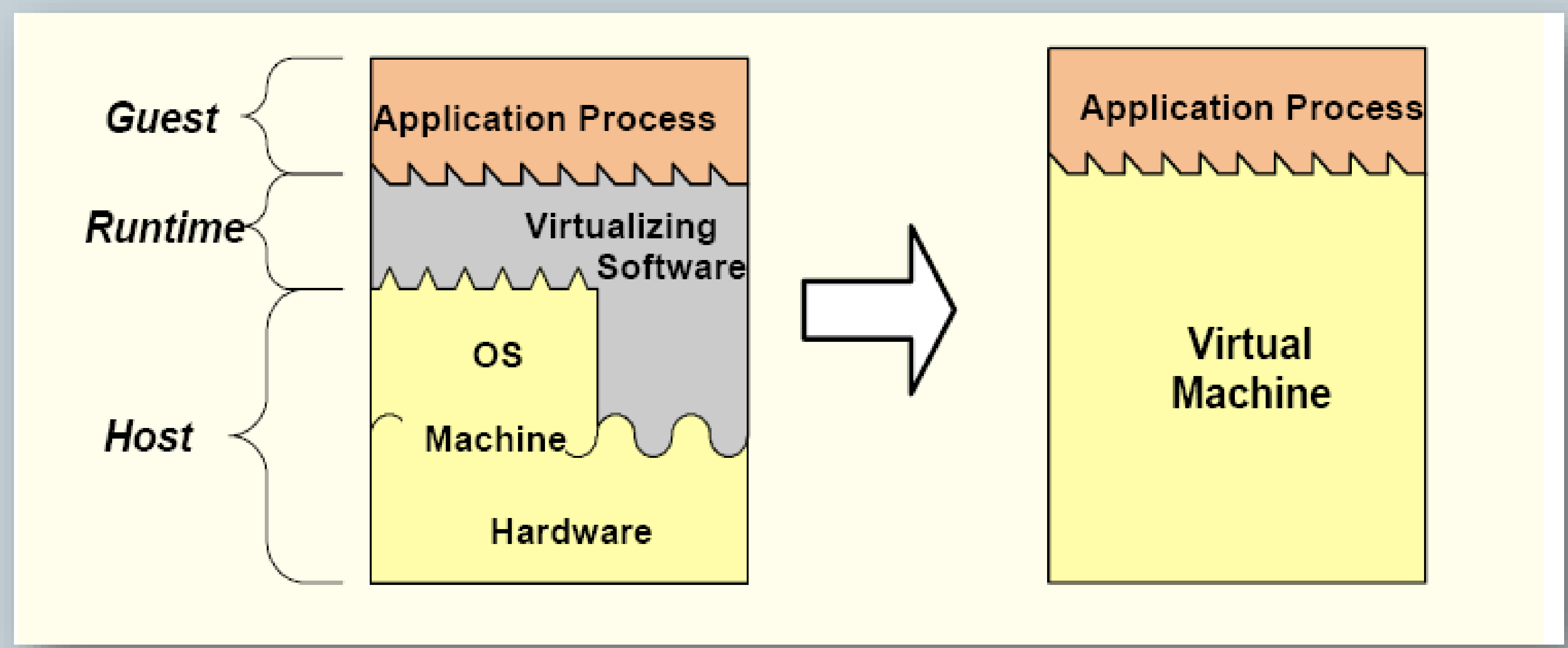
Types of Virtual Machine

- It provides a runtime environment **to execute a single program and supports a single process**.



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HLL VM

- HLL VM (High-Level Language Virtual Machine)
  - ✓ It is a system that provides **a process with an execution environment that does not correspond to any particular hardware platform**.
- HLL VMs are designed **to execute programs written in high-level programming languages**, such as Java, C#, Python, and Ruby.

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HLL VM

- They **provide language-specific runtime environments** that abstract hardware details and enable cross-platform compatibility.
- HLL VMs are language-agnostic and can **run code written in multiple high-level languages**.
- Examples include the **Java Virtual Machine (JVM) and the Common Language Runtime (CLR) for .NET languages**.

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HLL VM

- Examples of HLL VM:
  - ✓Java Virtual Machine (JVM): It provides an execution environment for Java programs.
  - ✓.NET Common Language Runtime (CLR): It provides an execution environment for .NET applications, including those written in C#, Visual Basic, and F#.
  - ✓Python Virtual Machine (PVM): It provides an execution environment for Python programs.
  - ✓Ruby Virtual Machine (YARV): It is the virtual machine for the Ruby programming language.

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