Virtualization

أ.ندى الوادعي

Definition of Virtualization:

Virtualization is the most significant among several enabling technologies of cloud computing. In fact, technologist could think about the delivery of computing resources as service stepping on the concept of virtualization. Along with this, implementation of many essential features of cloud computing has been made possible by virtualization technique. A software module called 'hypervisor' plays critical role in virtualization.

- Virtualization is the creation of a virtual -- rather than actual
- Virtualization is software that makes computing environments independent of physical infrastructure
- Virtualization is technology that you can use to create virtual representations of servers, storage, networks, and other physical machines
- Examples virtual classroom etc.
- The special layer of software (installed over active physical machines) is referred as **layer of virtualization**.
- This layer transforms the physical computing resources into virtual form which users use to satisfy their computing needs.

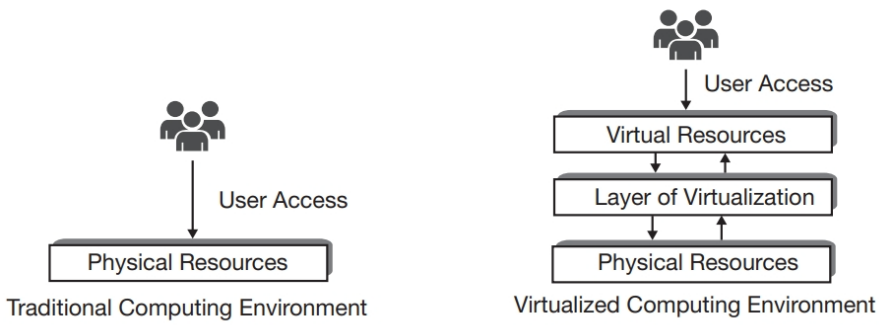


FIG 7.1: Users' interaction with computer in traditional and virtualized computing environment

In simple sense, the virtualization is the logical separation of physical resources from direct access of users to fulfill their service needs

Virtualization decouples the physical computing resources from direct access of user

Following are some reasons for using virtualization:

- Virtual machines (VM) merge the workloads of under-utilized servers. Because of this one can save on hardware, environmental costs and management.
- To run legacy applications, VM is used.
- VM provides a secured and sandbox for running an untrusted application.
- VM helps in building secured computing platform.
- VM provides an illusion of hardware.
- VM simulates networks of independent computers.
- VM supports to run distinct OS with different versions.
- VMs are uses for performance monitoring. Operating systems can be checked without disturbing the productivity.
- VM provides fault and error containment.
- VM tools are good for research and academic experiments.
- VM can encapsulate the entire state of a system by saving, examining, modifying and reloading.
- VM enables to share memory in multiprocessor architecture.
- VM makes the job easier for the administrative staff in migration, backup and recovery

VIRTUALIZING PHYSICAL COMPUTING RESOURCE:

- Any kind of computing resources can be virtualized. Apart from basic computing devices like processor, primary memory, other resources like storage, network devices (like switch, router etc.), the communication links and peripheral devices (like keyboard, mouse, printer etc.) can also be virtualized.

- But it should be noted that in case of core computing resources virtualized component can only be operational when a physical resource empowers it from the back end. For example, a virtual processor can only work when there is a physical processor linked with it.

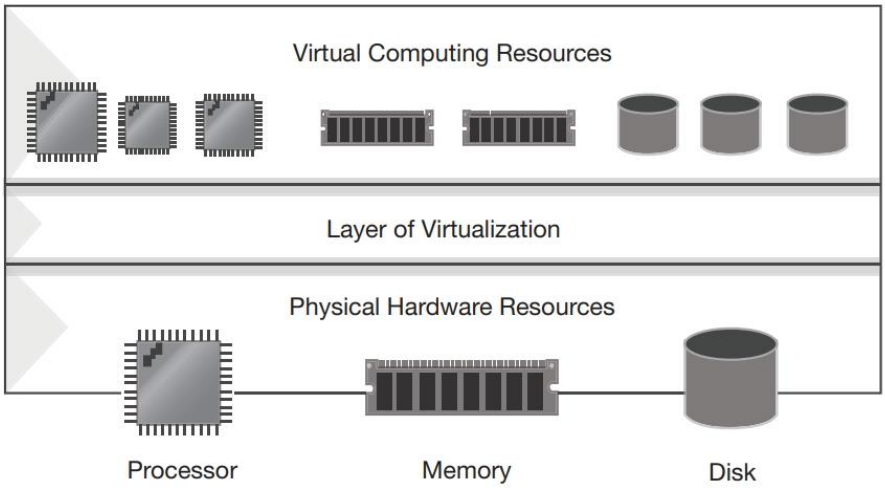


FIG 7.2: Transformation of physical resources into virtual resources through virtualization

- The important thing here to be noted is that the simulated devices produced through virtualization may or may not resemble the actual physical components (in quality, architecture or in quantity).
- For instance, in the given figure below, users get access to three processors while there is one physical processor in reality. Or, 32-bit processor can be produced (in virtual form) from 64-bit actual physical processor

MACHINE OR SERVER LEVEL VIRTUALIZATION:

- Machine virtualization (also called server virtualization) is the concept of creating virtual machine (or virtual computer) on actual physical machine.
- The parent system on which the virtual machines run is called the host system.
- and the virtual machines are themselves referred as guest systems.
- All these virtual machines running over a single host system, remain independent of each other
- Operating systems are installed into those virtual machines.
- These guest systems can access the hardware of the host system and can run applications within its own operating environment.

Virtualized physical server can host multiple virtual machines, where each one of them can have a different OS.

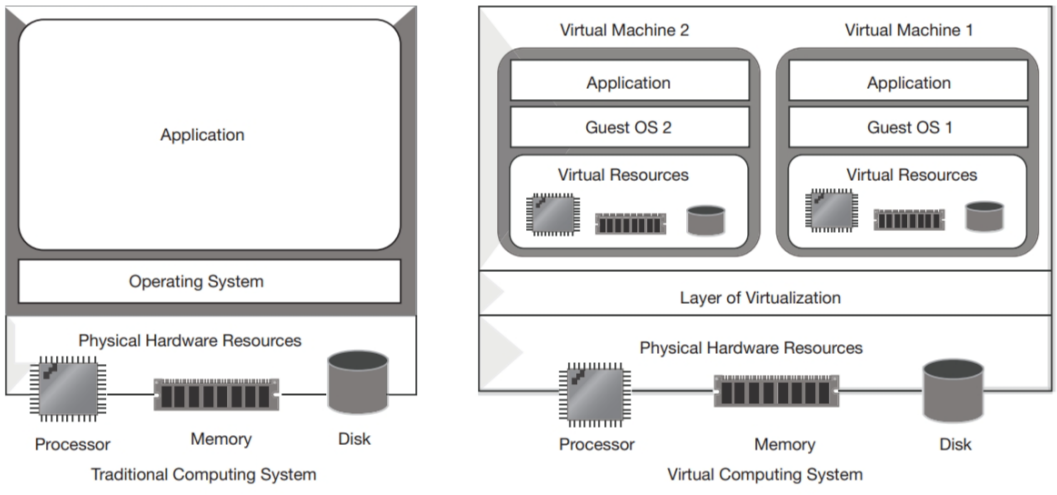


FIG 7.3: Conventional computing system versus Virtualized computing system

Comparison between non-virtualized and virtualized machine environment:

Non-Virtualized Machine Environment	Virtualized Machine Environment
At a moment, one single OS can run on a physical machine.	multiple OS can run simultaneously on one physical machine.
Application and hardware system remain tightly coupled.	virtual Machines isolates applications from the underlying hardware
Resource utilization rate is low in most of the times.	resource utilization improves as multiple VMs share same set of physical resources.
These increase cost of business due to low resource utilization.	they are cost-effective if planned properly.
They have the inflexible approach.	They provide lot of flexibility to system designers.

The Layer of Virtualization:

- From Figure 7.3, it can be seen that virtual machines are created over the virtualization layers.
- This virtualization layer is actually a set of control programs that creates the environment for the virtual machines to run on.
- This layer provides the access to the system resources to the virtual machines. It also controls and monitors the execution of the virtual machines over it.
- This software layer is referred as the Hypervisor or Virtual Machine Monitor (VMM).
- Hypervisor is software that creates, runs, manage and monitor your virtual machines (VMs)

Machine Virtualization Technique:

There are two different techniques of server or machine virtualization:

- hosted approach.
- the bare metal approach.

Hosted Approach (Type 2):

- In this approach, an operating system is first installed on the physical machine to activate it.
- This OS installed over the host machine is referred as host operating system.
- The hypervisor is then installed over this host OS.
- This type of hypervisor is referred to as Type 2 hypervisor or Hosted hypervisor.

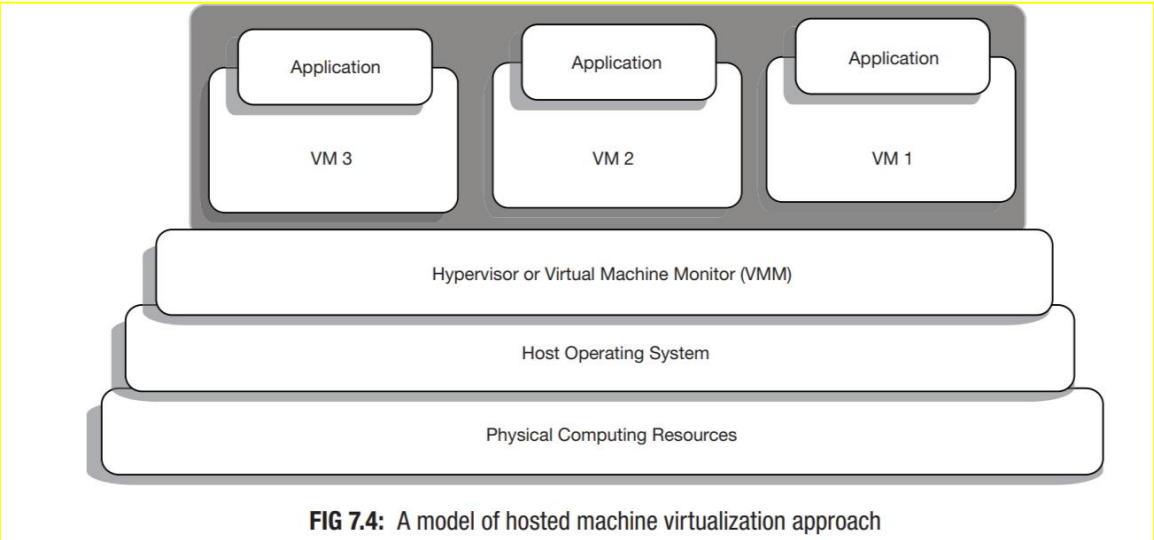


FIG 7.4: A model of hosted machine virtualization approach

- here the host OS works as the first layer of software over the physical resources.
- Hypervisor is the second layer of software and guest operating systems run as the third layer of software.
- Products like VMWare Workstation and Microsoft Virtual PC are the most common examples of type 2 hypervisors.

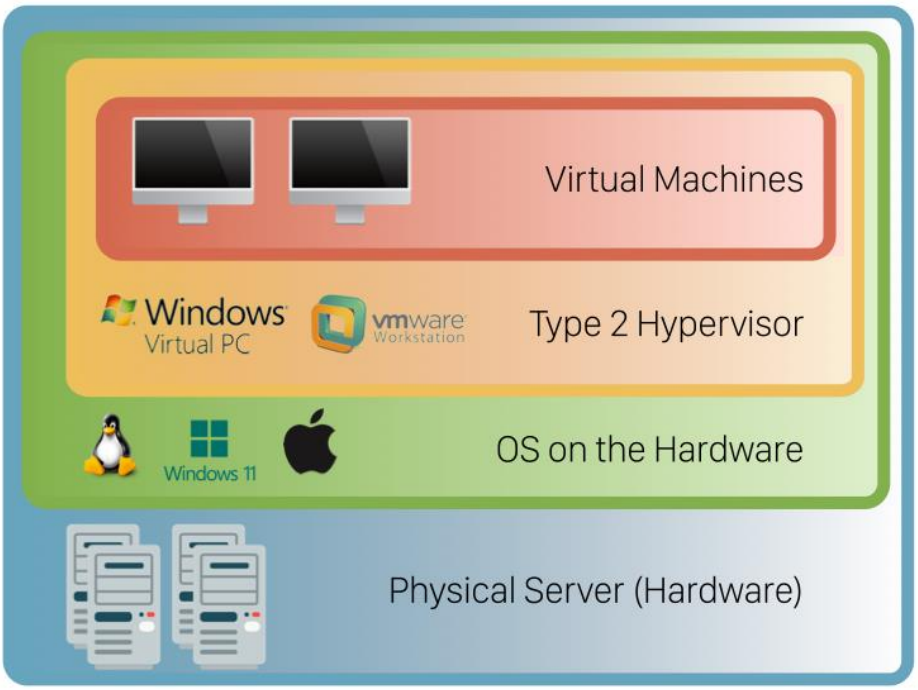
✓ Benefits:

In this approach, the host OS supplies the hardware drivers for the underlying physical resources. This eases the installation and configuration of the hypervisor. It makes the type-2 hypervisors compatible for a wide variety of hardware platform.

✓ Drawbacks:

- A hosted hypervisor does not have direct access to the hardware resources
- and hence, all of the requests from virtual machines must go through the host OS.
- This may degrade the performance of the virtual machines.
- Another drawback of the hosted virtualization is the lack of support for real-time operating systems.
- Since the underlying host OS controls the scheduling of jobs it becomes unrealistic to run a real-time OS inside a VM using hosted virtualization.

Type 2 or hosted hypervisors run within an operating-system environment.



Bare Metal Approach: Removal of the Host OS (Type 1):

- In this approach of machine virtualization, the hypervisor is directly installed over the physical machine.
- Since, the hypervisor is the first layer over hardware resources, hence, the technique is referred as bare metal approach.
- Here, the VMM or the hypervisor communicates directly with system hardware.
- In this approach, the hypervisor acts as low-level virtual machine monitor and also called as Type 1 hypervisor or Native Hypervisor.
- Contact with system hardware is not possible in Type 2
- Performance is very high in Type1
- Like: VMware's ESX and ESXi Servers, Microsoft's Hyper-V, solution Xen are some of the examples of bare-metal hypervisors.

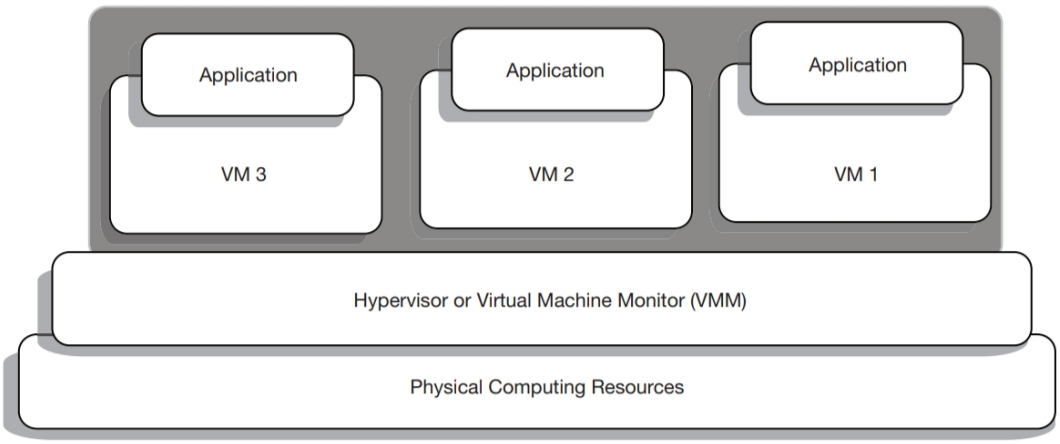


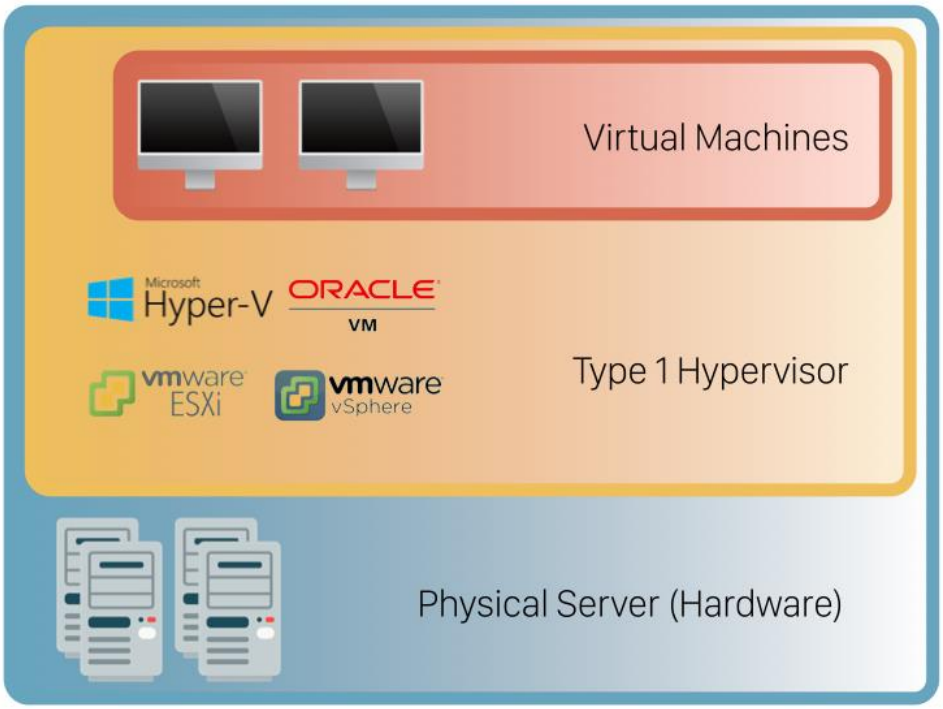
FIG 7.5: A model for the bare metal approach of machine virtualization

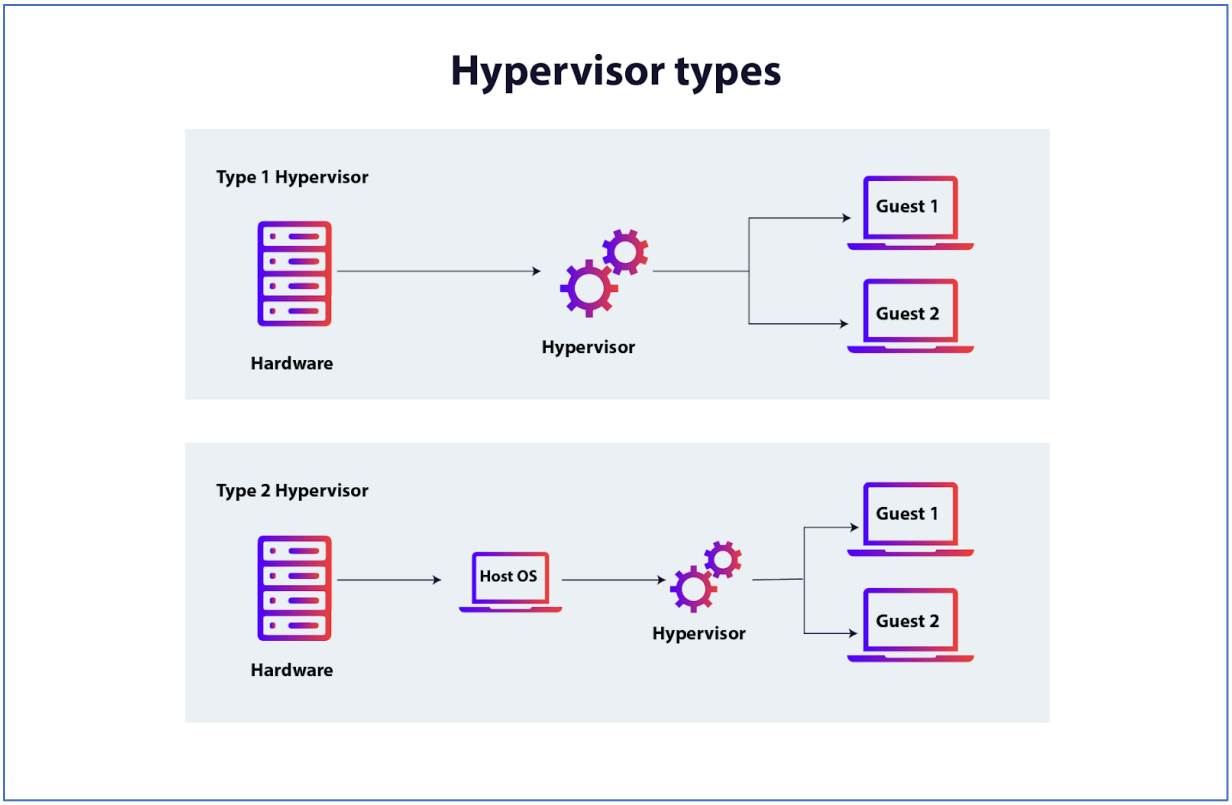
✓ Benefits:

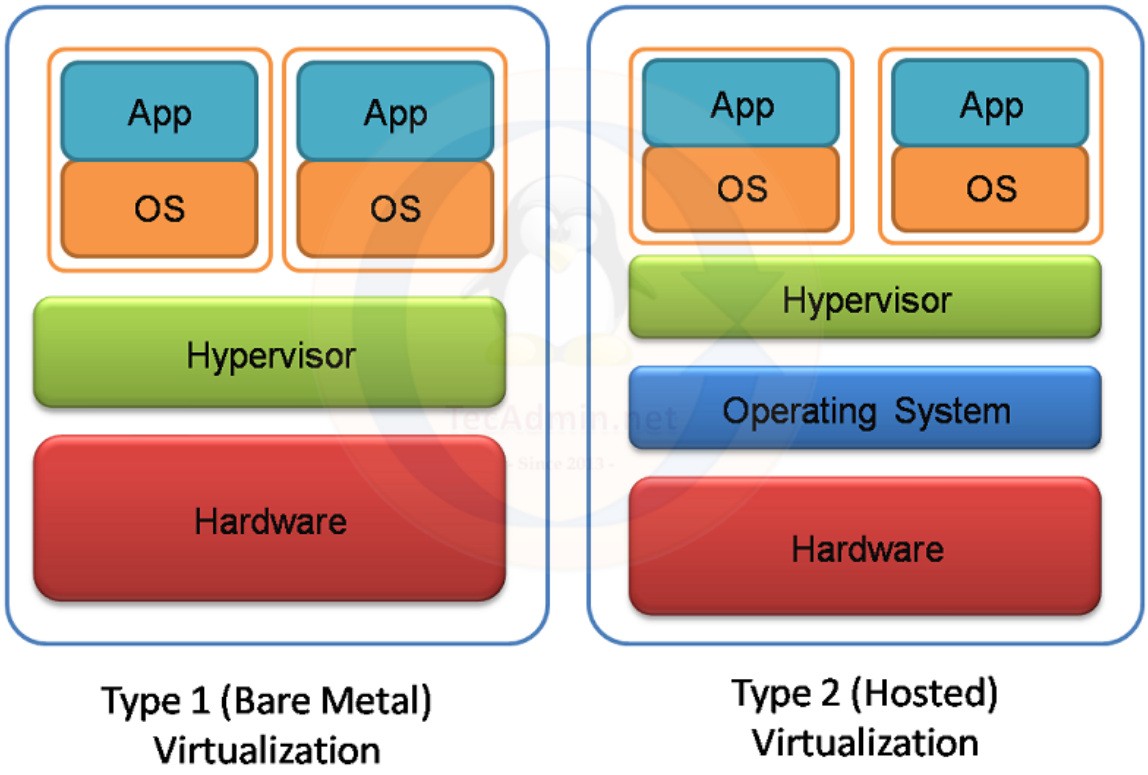
Since the bare metal hypervisor can directly access the hardware resources in most of the cases it provides better performance in comparison to the hosted hypervisor. For bigger application like enterprise data centers, bare-metal virtualization is more suitable because usually it provides advanced features for resource and security management. Administrators get more control over the host environment.

✓ Drawbacks:

As any hypervisor usually have limited set of device drivers built into it, so the bare metal hypervisors have limited hardware support and cannot run on a wide variety of hardware platform.







Type 1 (Bare Metal) Virtualization

Type 2 (Hosted) Virtualization