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Principles of Cloud Virtualization Concepts

Lecture (4)

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Virtualization Concepts

Virtualization technology is one of the fundamental components of cloud computing, especially in regard to infrastructure-based services. Virtualization allows the creation of a secure, customizable, and isolated execution environment for running applications, even if they are untrusted, without affecting other users' applications. The basis of this technology is the ability of a computer program—or a combination of software and hardware—to emulate an executing environment separate from the one that hosts such programs. For example, we can run Windows OS on top of a virtual machine, which itself is running on Linux OS. Virtualization provides a great opportunity to build elastically scalable systems that can provision additional capability with minimum costs. Therefore, virtualization is widely used to deliver customizable computing environments on demand.

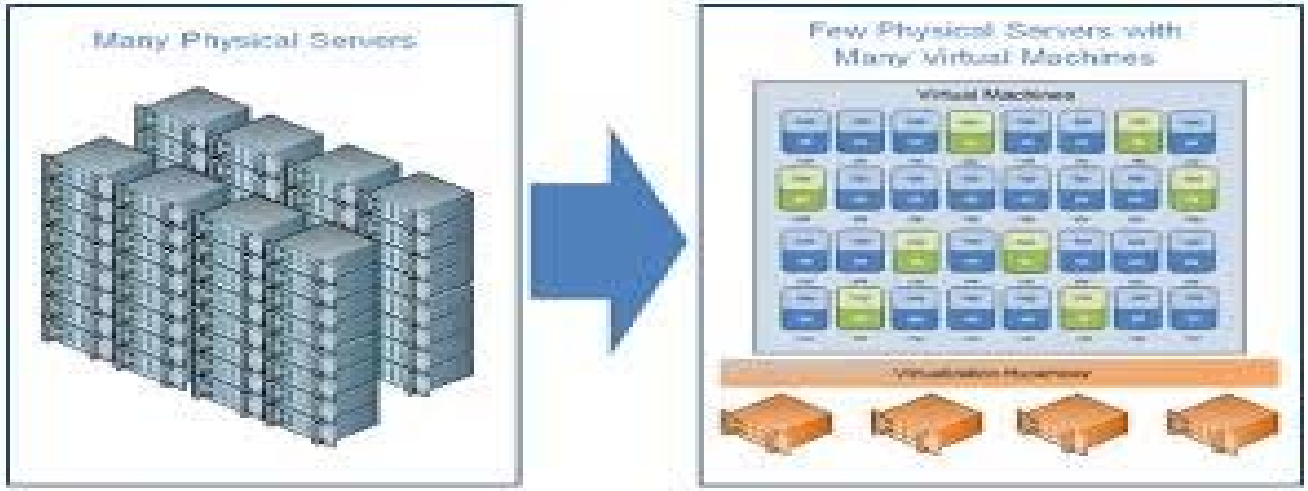
Virtualization

Virtualization is a large umbrella of technologies and concepts that are meant to provide an abstract environment—whether virtual hardware or an operating system—to run applications.

- the operating system level,
- the programming language level,
- and the application level
- Moreover, virtualization technologies provide a virtual environment for not only executing applications but also for storage, memory, and networking.

Why Virtualization??

- Increased performance and computing capacity.
- Underutilized hardware and software resources.
- Lack of space. Which leads to server consolidation.
- Greening initiatives
- Rise of administrative costs.



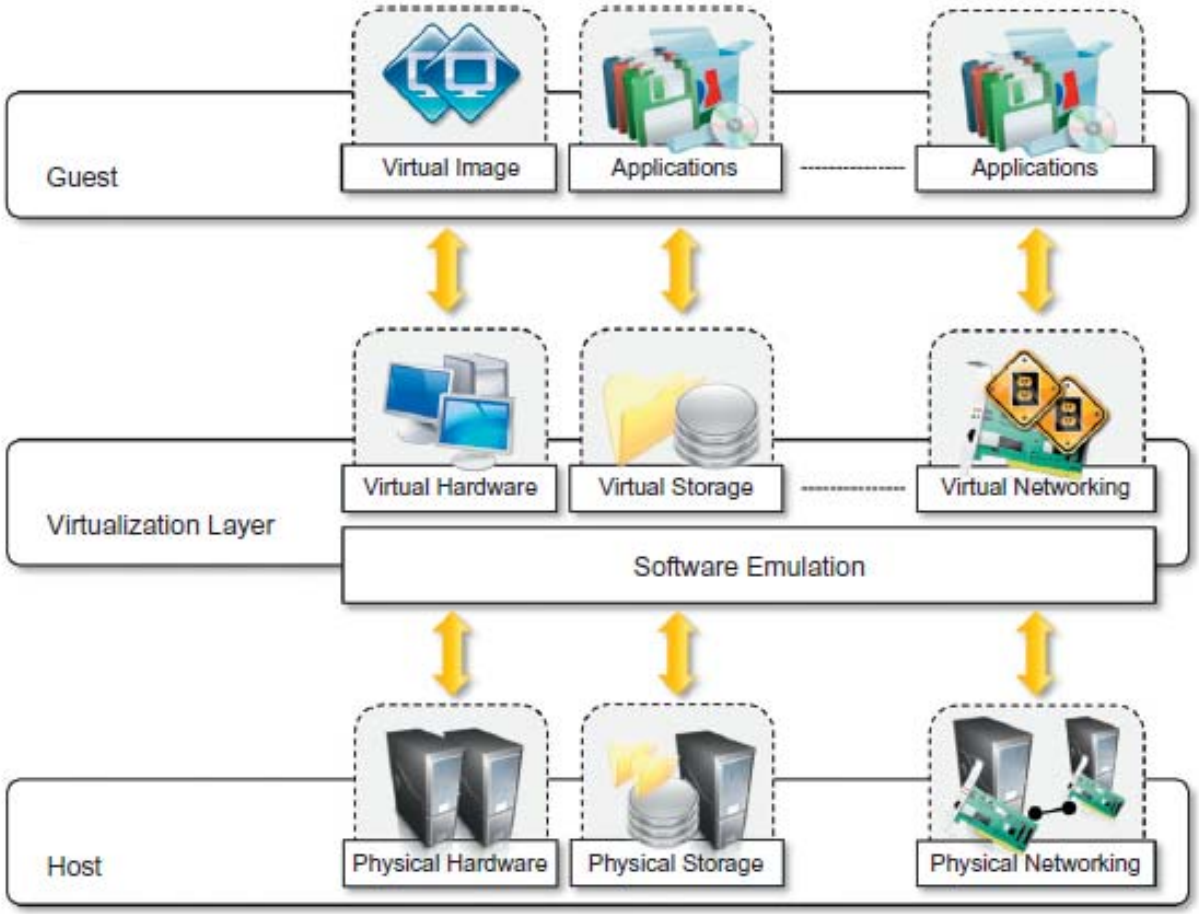
Virtualization Characteristics

Guest, host and virtual layer

Example: hard ware virtualization

- Guest
- virtual machine manager.
- The host is instead represented by the physical hardware, and in some cases the operating system

Virtualization Characteristics



Cloud Virtualization Properties

- Increased security

The ability to control the execution of a guest in a completely transparent manner opens new possibilities for delivering a secure, controlled execution environment. The virtual machine represents an emulated environment in which the guest is executed. All the operations of the guest are generally performed against the virtual machine, which then translates and applies them to the host. This level of indirection allows the virtual machine manager to *control* and *filter* the activity of the guest, thus preventing some harmful operations from being performed. Resources exposed by the host can then be hidden or simply protected from the guest. Moreover, sensitive

- Managed execution

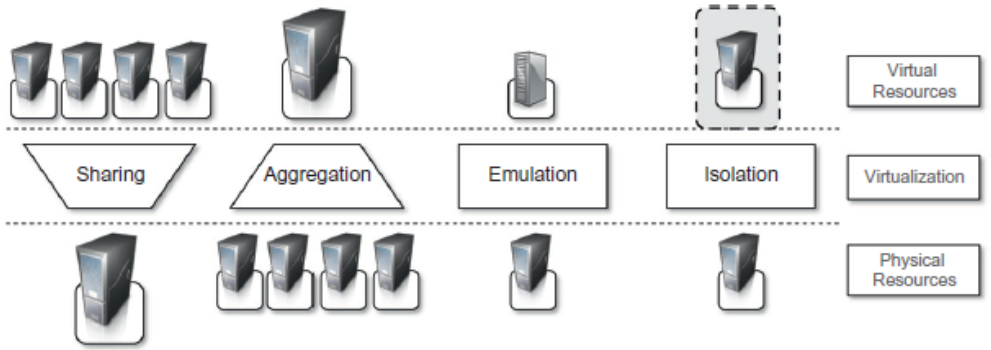
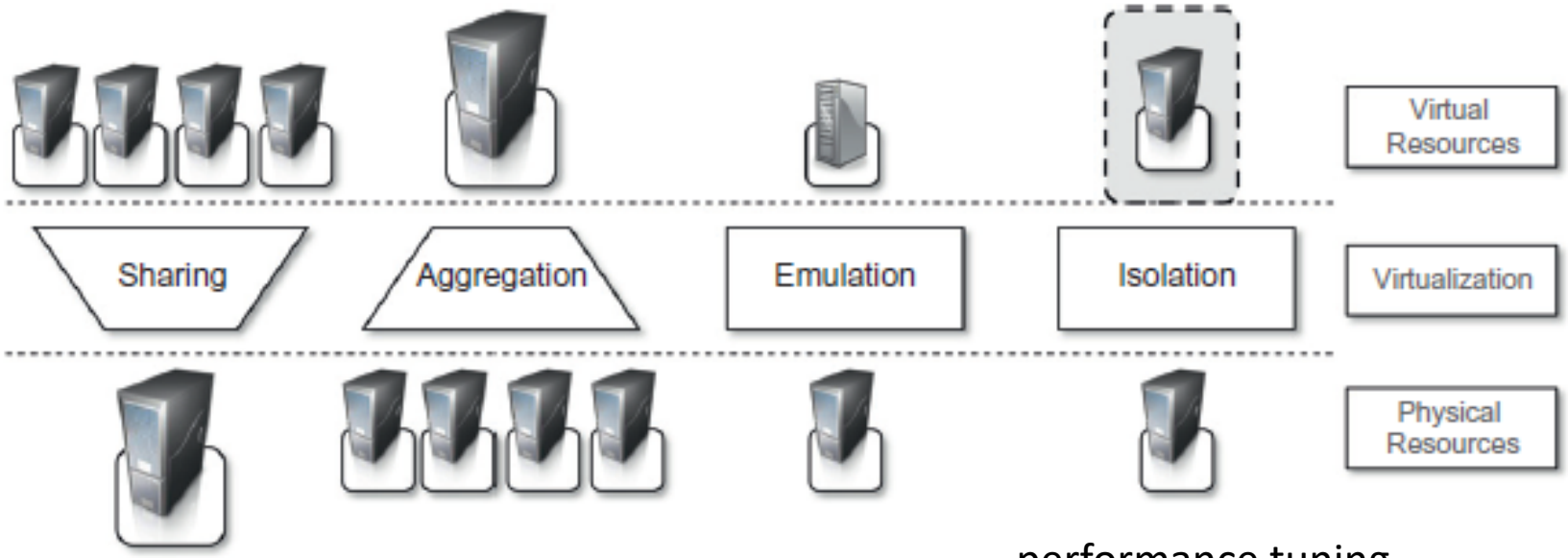


FIGURE 3.2

Functions enabled by managed execution.

Cloud Virtualization Properties

- Managed execution



performance tuning.

FIGURE 3.2

Functions enabled by managed execution.

Cloud Virtualization Properties

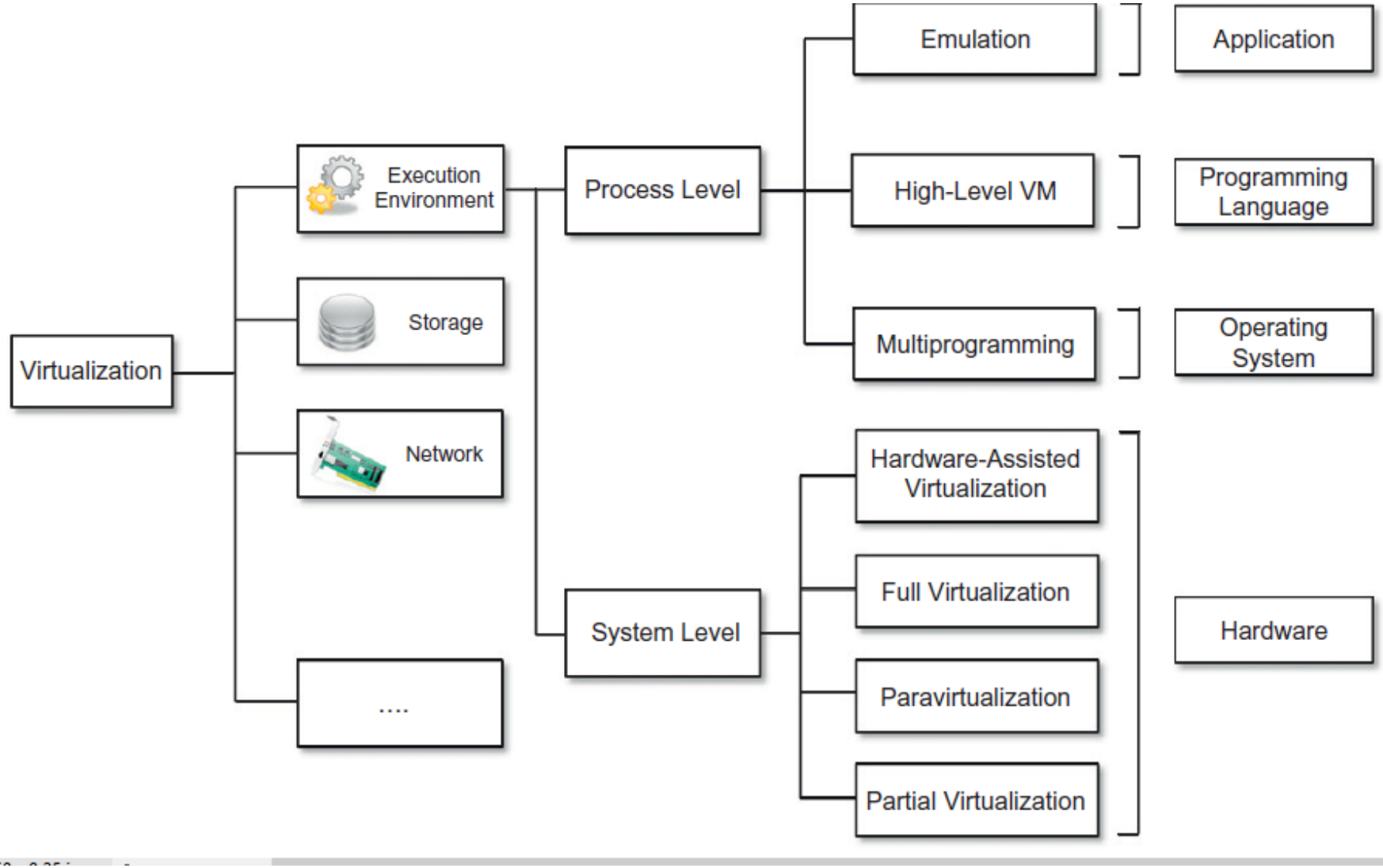
- Portability

This makes the application development cycle more flexible and application deployment very straightforward: One version of the application, in most cases, is able to run on different platforms with no changes. Finally, portability allows having your own system always with you and ready to use as long as the required virtual machine manager is available. This requirement is, in general, less stringent than having all the applications and services you need available to you anywhere you go.

Taxonomy of virtualization techniques

Process-level techniques are implemented on top of an existing operating system, which has full control of the hardware. *System-level* techniques are implemented directly on hardware and do not require—or require a minimum of support from—an existing operating system. Within these two categories we can list various techniques that offer the guest a different type of virtual computation environment: bare hardware, operating system resources, low-level programming language, and application libraries.

Taxonomy of virtualization techniques



Machine Reference Model

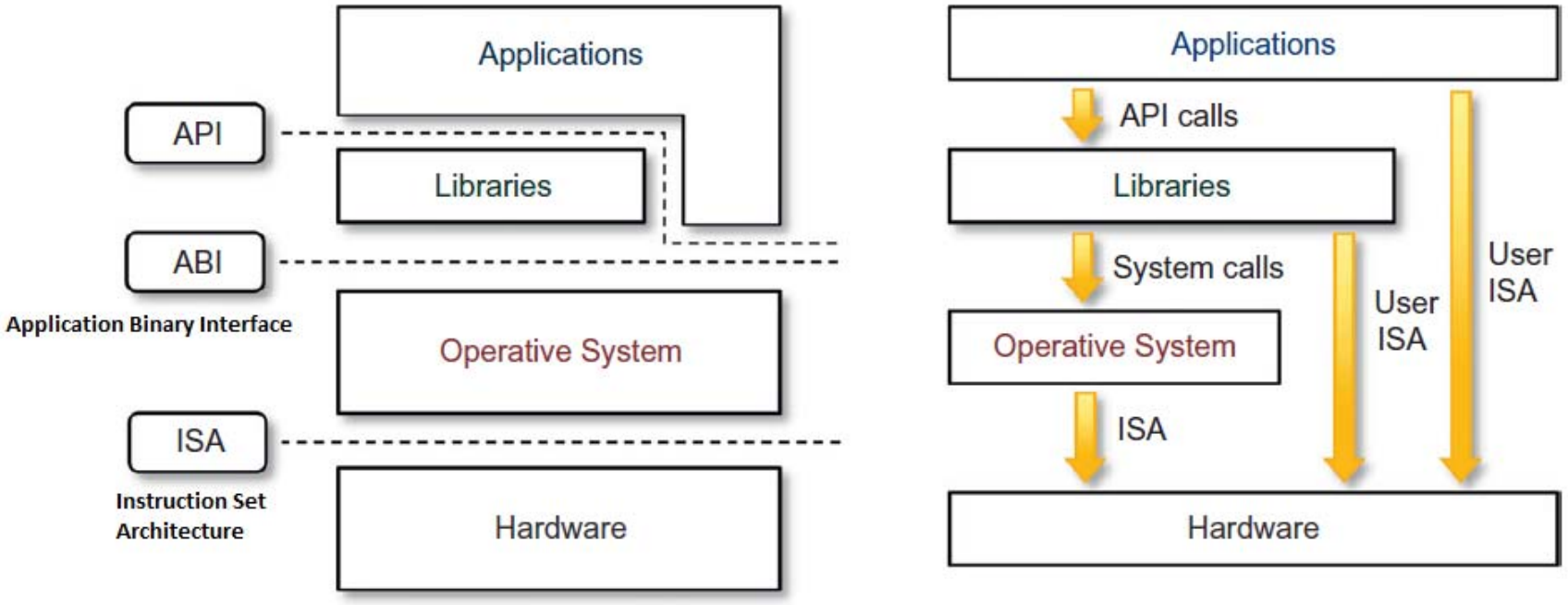


FIGURE 3.4

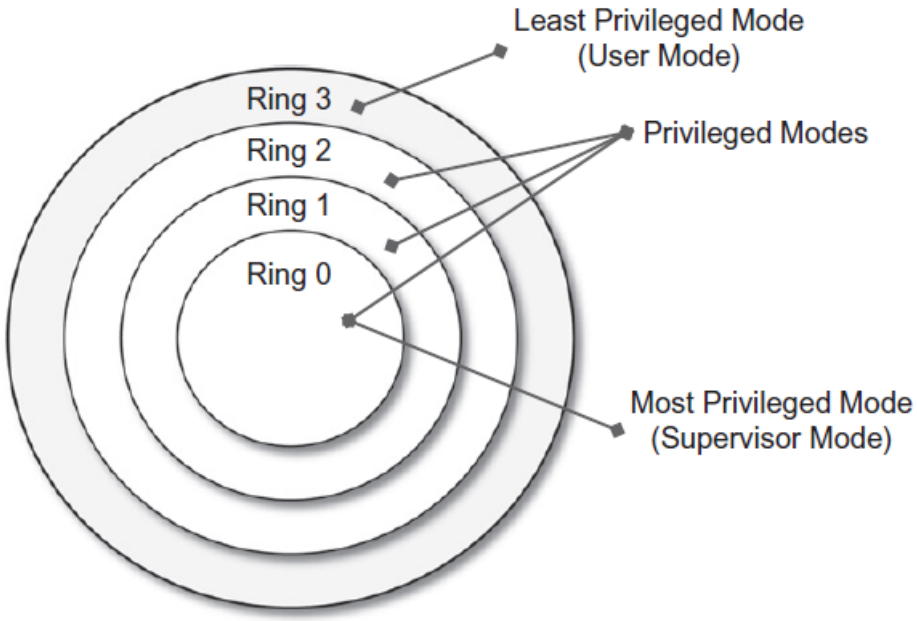
A machine reference model.

This interface allows portability of applications and libraries across operating systems that that use the same ABI. This model provides Security

Machine Refence Model

Privilege and non-privilage instructions

Ring 0, *Ring 1*, *Ring 2*, and *Ring 3*; Ring 0 is in the most privileged level and Ring 3 in the least privileged level. Ring 0 is used by the kernel of the OS, rings 1 and 2 are used by the OS-level services, and Ring 3 is used by the user. Recent systems support only two levels, with Ring 0 for supervisor mode and Ring 3 for user mode.



Hypervisor

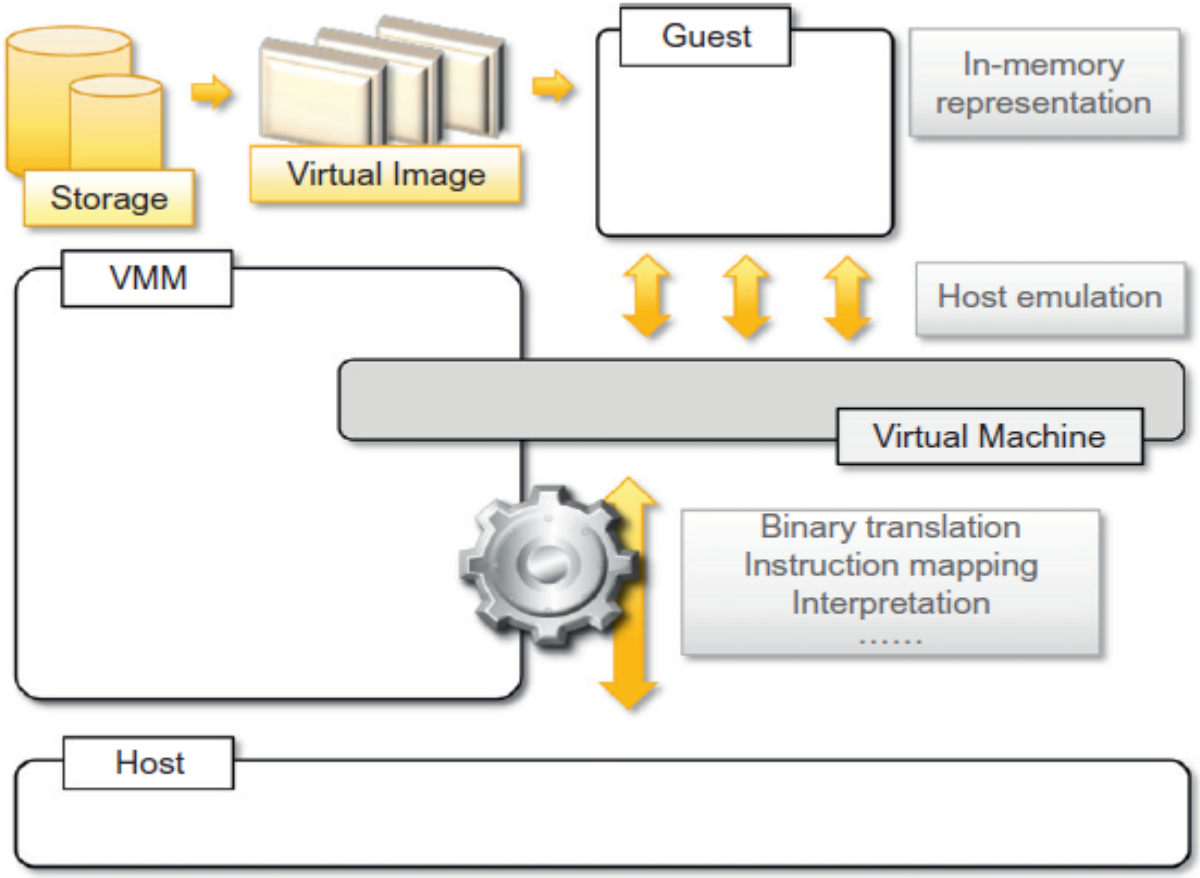
Hardware-level virtualization

Hardware-level virtualization

Hardware-level virtualization is a virtualization technique that provides an abstract execution environment in terms of computer hardware on top of which a guest operating system can be run. In this model, the guest is represented by the operating system, the host by the physical computer hardware, the virtual machine by its emulation, and the virtual machine manager by the hypervisor (see Figure 3.6). The hypervisor is generally a program or a combination of software and hardware that allows the abstraction of the underlying physical hardware.

Hardware-level virtualization is also called *system virtualization*, since it provides ISA to virtual machines, which is the representation of the hardware interface of a system. This is to differentiate it from *process virtual machines*, which expose ABI to virtual machines.

Hardware-level virtualization



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