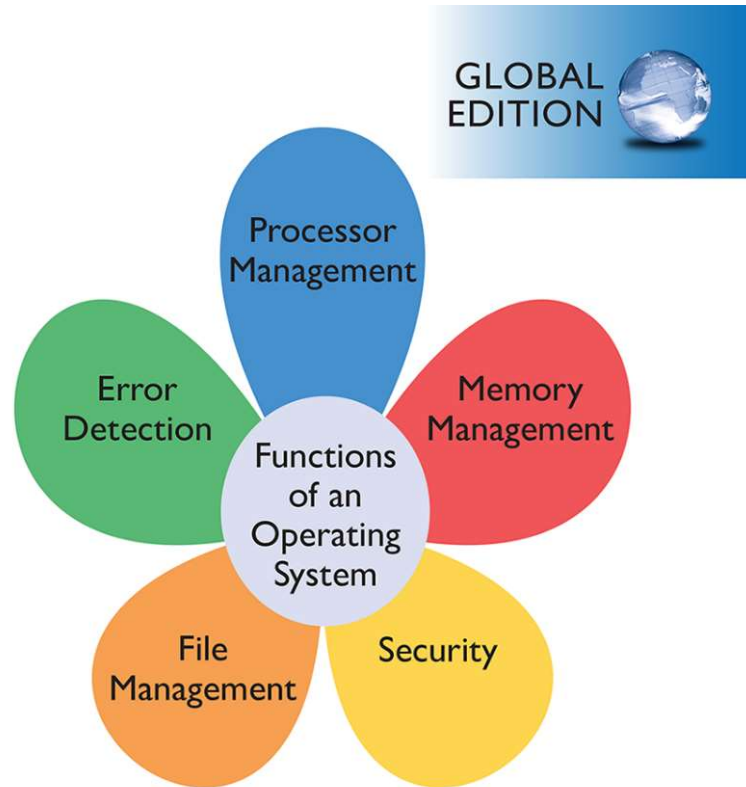


Modern Operating Systems

Fifth Edition, Global Edition



Chapter 7

Virtualization and The Cloud

Modern Operating Systems

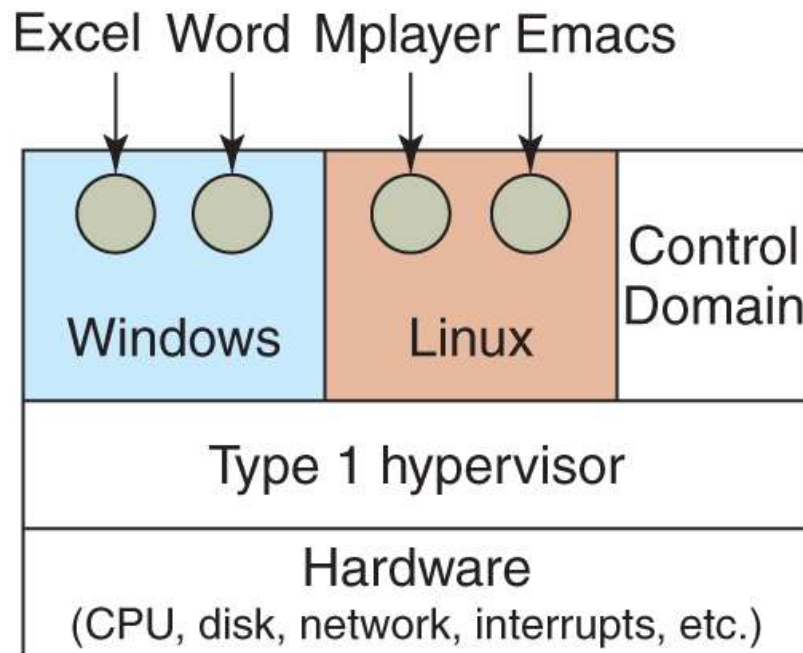
FIFTH EDITION

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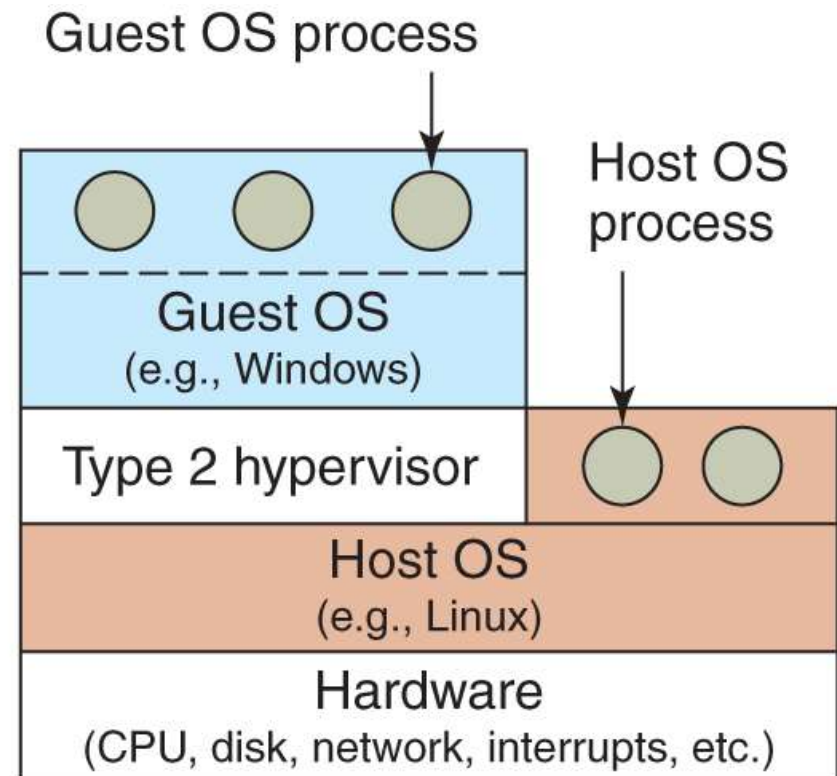


Hypervisor (Virtual Machine Manager)

Location of type 1 and type 2 hypervisors.



(a)



(b)

Types of Hypervisors

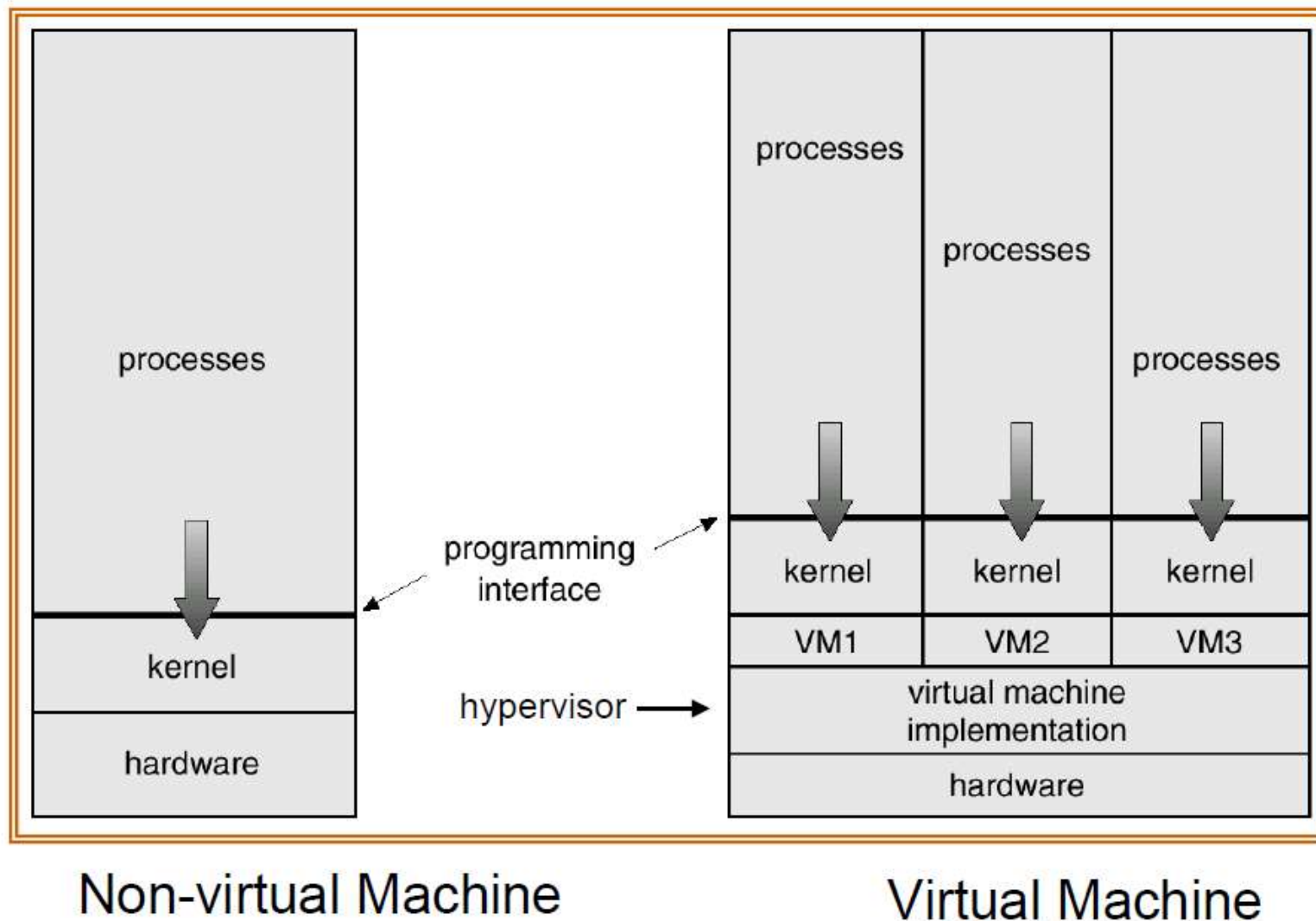
Virtualization method	Type 1 hypervisor	Type 2 hypervisor
Virtualization without HW support	ESX Server 1.0	VMware Workstation 1
Paravirtualization	Xen 1.0	VirtualBox 5.0+
Virtualization with HW support	vSphere, Xen, Hyper-V	VMware Fusion, KVM, Parallels
Process virtualization		Wine

Type 1 hypervisors run on the bare metal

Type 2 hypervisors use the services of an existing host operating system.

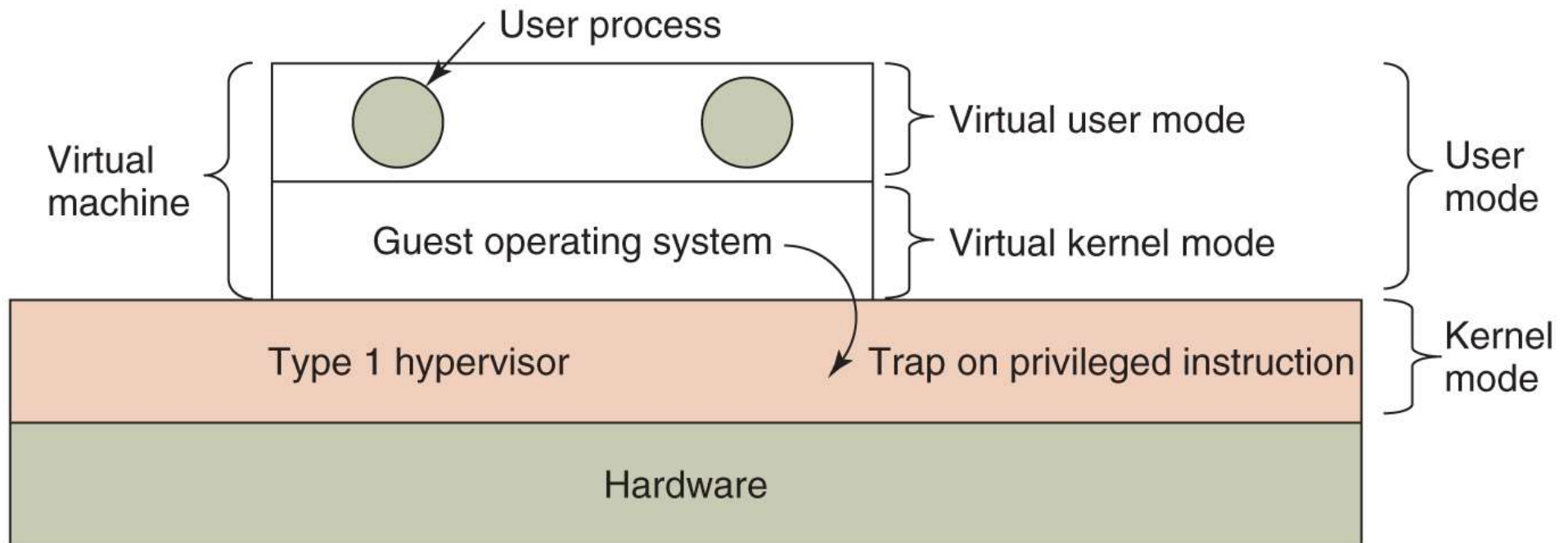
Type 2 Hypervisor (VM Manager)

Provides emulation of multiple physical machines called virtual machines

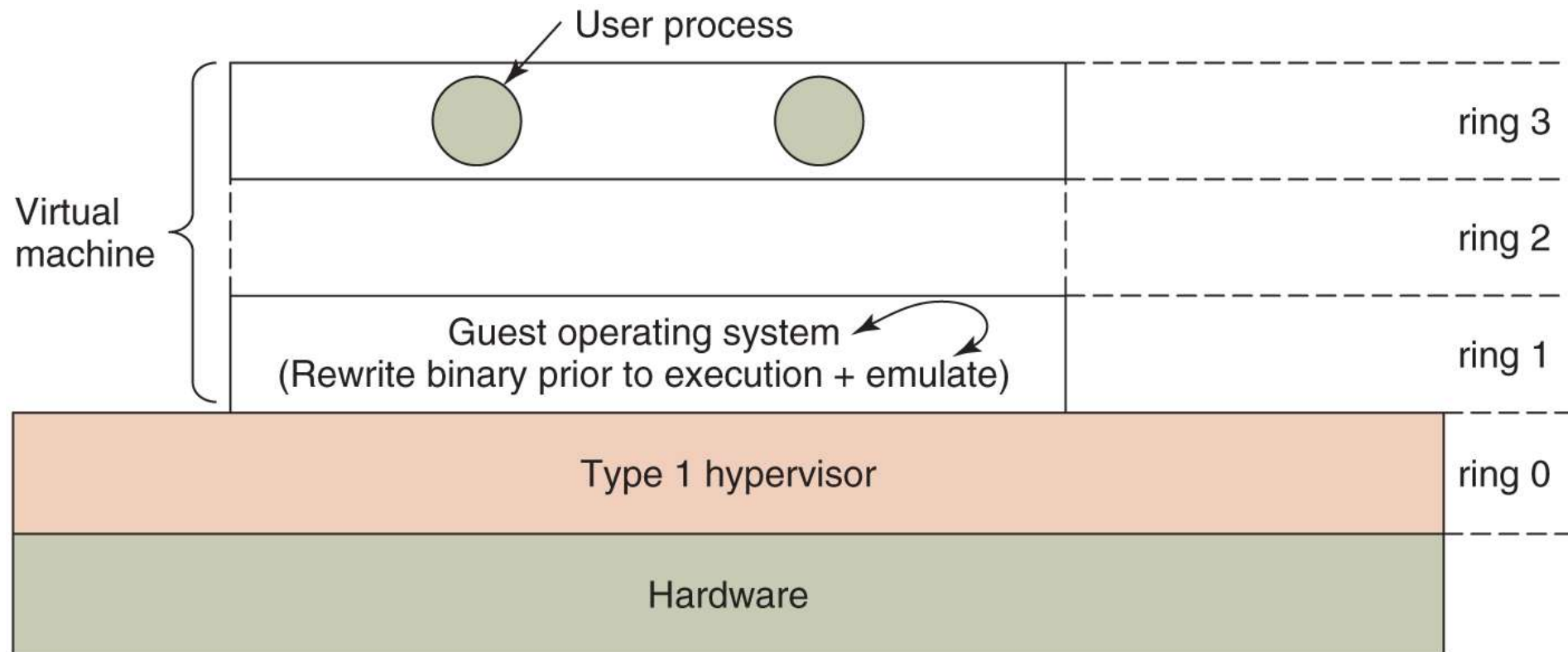


Type 1 Hypervisor: Traps

When a guest OS executes a kernel-only instruction, it traps to the hypervisor if virtualization technology is present



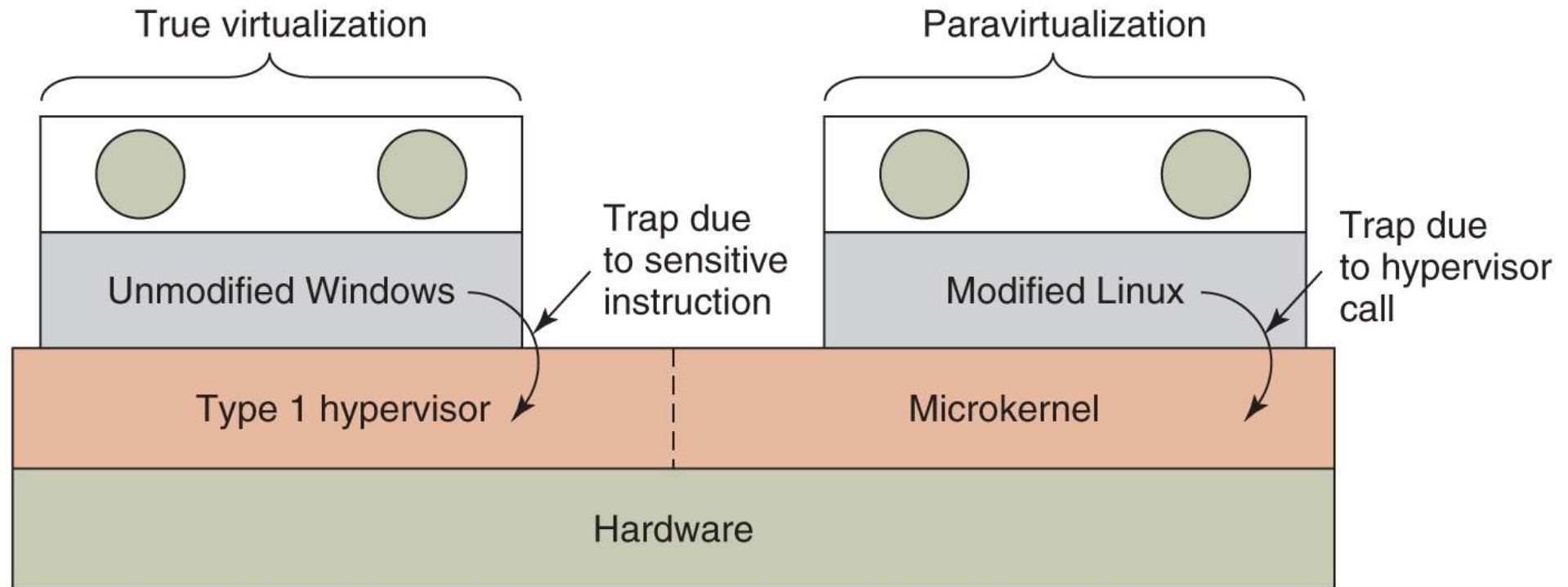
Type 1 Hypervisor



In early x86 virtualization, the binary translator of the VMM rewrites sensitive guest OS instructions so the guest could run in a less-privileged ring (often ring 1), while the hypervisor remained in ring 0

In modern hardware-assisted virtualization, the hypervisor typically runs in a higher privilege level (VMX root mode / hypervisor mode), while the guest OS can run in ring 0 inside a virtual machine.

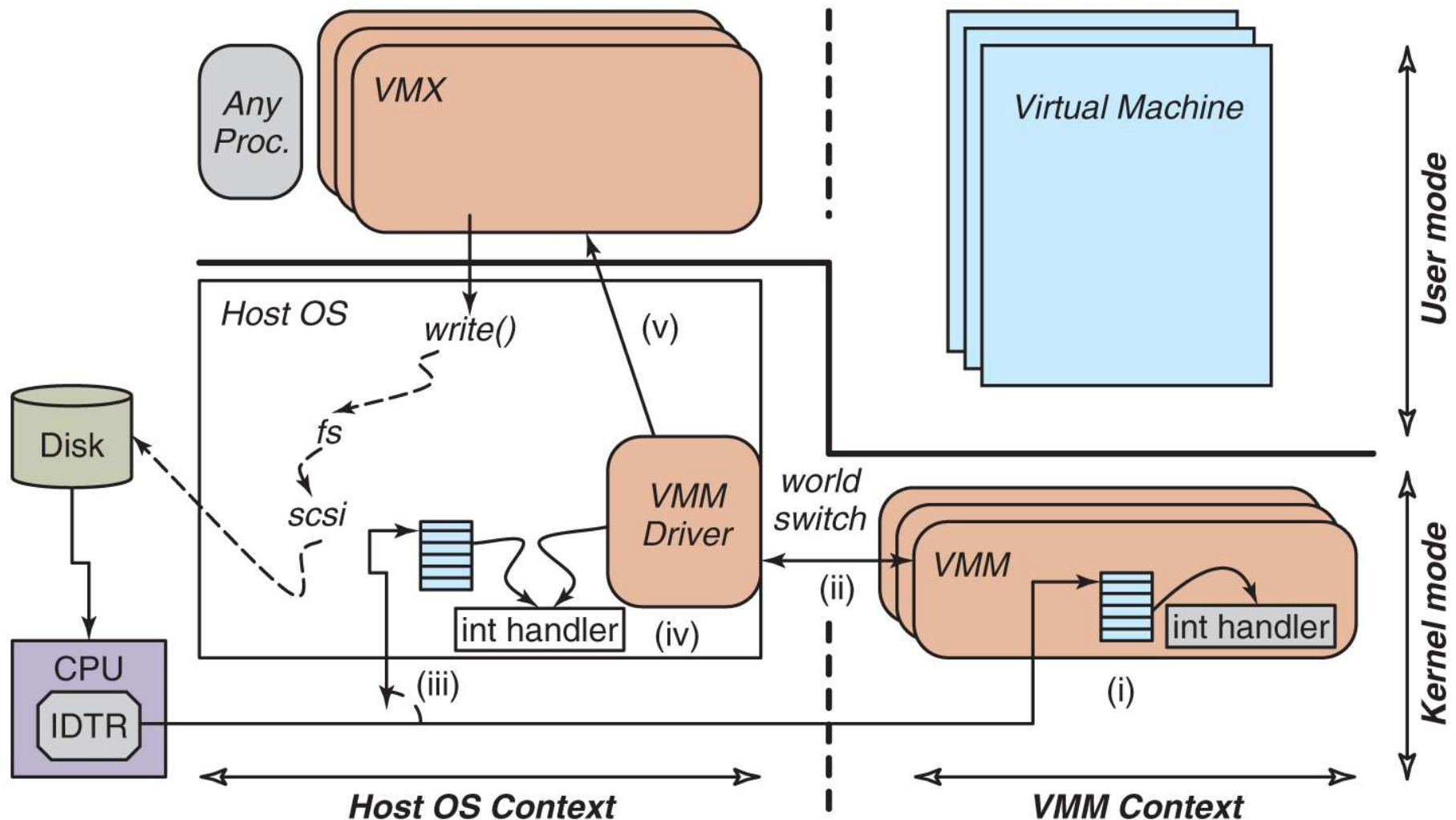
Full Virtualization vs ParaVirtualization



- Example with Type 1 Hypervisor
- Full: Sensitive instructions cause a trap to the hypervisor who emulates or handles privileged operations
- Paravirtualization: The guest OS makes explicit hypercalls to the hypervisor

VMware's Hosted Hypervisor

The VMware Hosted Architecture has three components: VMX, VMM driver, and VMM.



Examples of Context Switches

Difference between a normal context switch and a world switch

