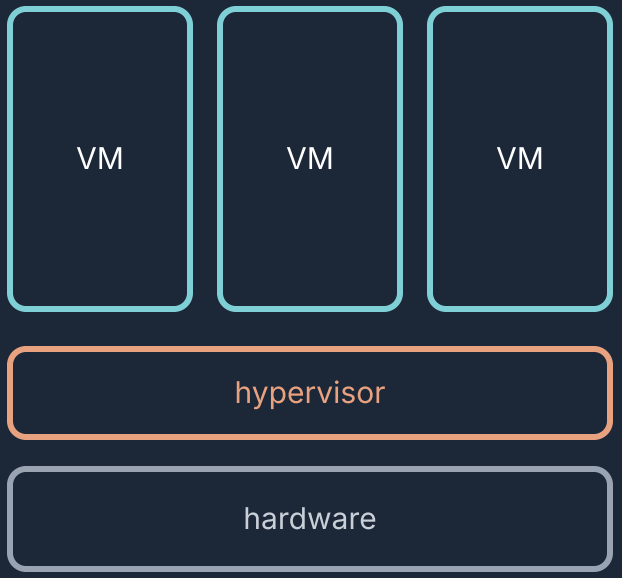
OPERATING SYSTEMS · LECTURE 15

Virtual Machines

Virtualization, hypervisors, benefits



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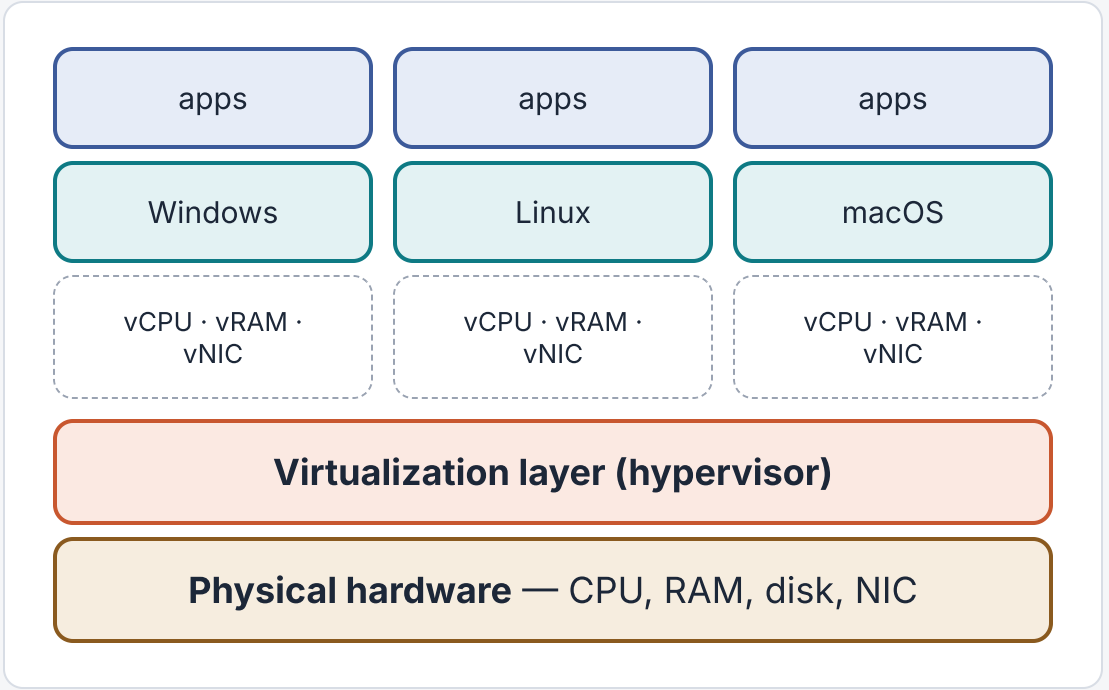
01 What is a virtual machine?

Software that creates a **virtual environment** between the hardware and the user, in which the user runs software.

> A VM provides an interface **identical to the bare hardware**. Each VM seems to have its own processor and memory.



02 Virtualization

An abstraction layer that **decouples** physical hardware from the operating system.

Better utilization

one physical machine runs many VMs

Heterogeneous OSs

different OSs side by side on the same machine

Isolation

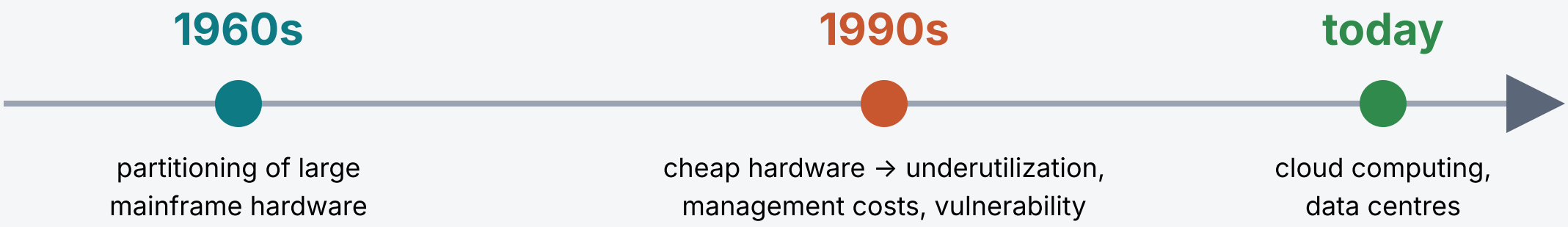
each VM has its own virtual hardware: RAM, CPU, NIC

> The OS inside a VM sees a **consistent, normalized** set of hardware, whatever the real hardware is.

03 Types of virtualization

TYPE	WHAT IT DOES
Data	combines data sources into one dynamic supply
Desktop	many simulated desktops managed by a central administrator
Server	partitions a server into configurations for specific functions
Operating system	runs several operating systems on one computer
Network functions	separates network functions (directory, file sharing, IP configuration) across environments

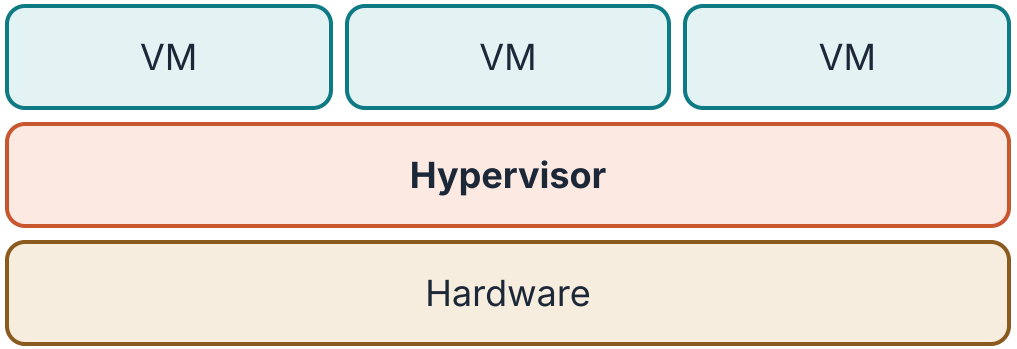
04 History


1960s
1990s
today
partitioning of large mainframe hardware
cheap hardware → underutilization, management costs, vulnerability
cloud computing, data centres

05 Hypervisor (Virtual Machine Monitor)

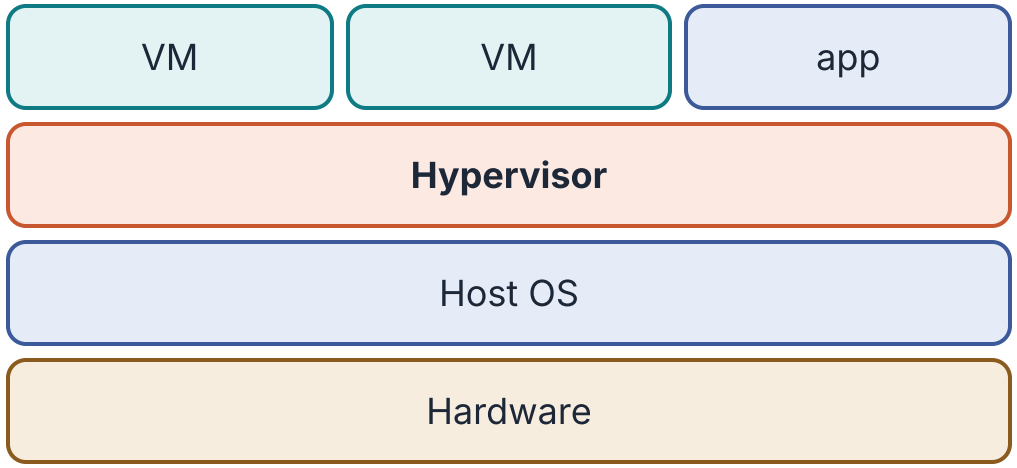
Host software that gives each VM the **illusion of a complete computer**. It partitions physical resources and schedules them; the real CPU still executes the instructions.

Type 1 — bare metal



Examples: **KVM** (Linux), VMware ESXi, Hyper-V

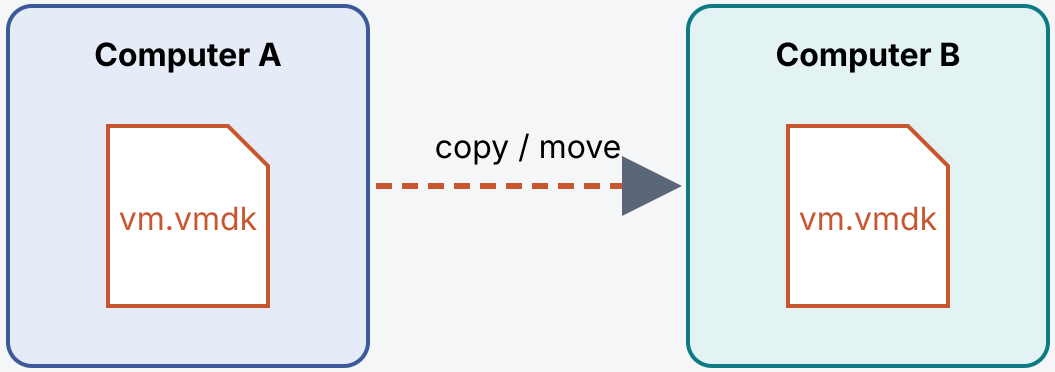
Type 2 — hosted



Examples: **VMware Workstation**, **Oracle VirtualBox**

06

A VM is just a file



A VM can be defined in a **single data file**: moved to another computer, opened there, and it works the same.

> Linux has a built-in hypervisor: **KVM** — Kernel-based Virtual Machine.

07

Benefits of virtual machines

Partitioning

many OSs and apps on one system; no memory overlap

Isolation

one VM crashes — others are unaffected; no data leaks between VMs

Utilization & ROI

no new server for every new OS

Scale

deploy many copies of a VM in the cloud as load grows

Portability & flexibility

move VMs between hosts; clone a ready VM instead of installing an OS

Security

scan the VM file; take a **snapshot** and roll back after malware

08 Summary

- VMs are **identical execution environments** on one computer, each with its own OS
- Applications for one OS can run on a machine with another OS
- Stronger isolation than processes in one OS instance

TERM	KEY IDEA
Virtualization	hardware ↔ OS decoupled
Hypervisor	creates and runs VMs
Type 1	on bare metal
Type 2	on a host OS
Snapshot	saved VM state to restore