

Introduction to Virtualization

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Key concepts, benefits, types, and common technologies

1. What Is Virtualization?

Aspect	Description
Definition	The creation of a logical (virtual) version of a physical resource—such as a server, storage device, network, or operating system—so that multiple isolated instances can run on a single piece of hardware.
Goal	Improve resource utilization, flexibility, and manageability while reducing cost and complexity.
Analogy	Like dividing a single physical computer into several independent “mini-computers” that each think they have their own hardware.

2. Core Components

Component	Role
Hypervisor (Virtual Machine Monitor)	Software layer that abstracts physical hardware and allocates it to virtual machines (VMs).
Virtual Machine (VM)	An isolated guest OS + applications that run on top of the hypervisor.
Host System	The physical server (hardware + OS) that runs the hypervisor.
Guest OS	The operating system installed inside a VM.
Virtual Devices	Emulated hardware (network adapters, disks, etc.) presented to the guest OS.

3. Types of Hypervisors

Type	Placement	Typical Use Cases
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Introduction to Virtualization

Type?1 (Bare?metal)	Runs directly on hardware, no underlying OS.	Data?center servers, cloud platforms (e.g., VMware ESXi, Microsoft Hyper?V, KVM, Xen).
Type?2 (Hosted)	Runs as an application on a host OS.	Desktop/laptop virtualization, development/testing (e.g., VMware Workstation, Oracle VirtualBox, Parallels Desktop).

4. Main Benefits

Benefit	Why It Matters
Higher Utilization	Consolidates many under?utilized servers into fewer physical machines.
Cost Savings	Reduces hardware purchase, power, cooling, and floor space.
Rapid Provisioning	New VMs can be cloned or scripted in minutes.
Isolation & Security	Faults or attacks in one VM don't affect others.
Disaster Recovery	Snapshots and live migration simplify backup and fail?over.
Testing & Development	Multiple OS versions can coexist on a single workstation.

5. Common Virtualization Models

Model	What Is Virtualized?	Typical Scenarios
Server Virtualization	Entire physical server (CPU, memory, storage, network).	Data?center consolidation, cloud IaaS.
Desktop Virtualization	User desktop environment (VDI) or local VM.	Remote work, secure corporate desktops.
Application Virtualization	Individual apps run in isolated containers.	Reducing DLL conflicts, simplifying deployment.
Storage Virtualization	Pools multiple storage devices into a single logical store.	Simplified management, tiered storage.
Network Virtualization	Abstracts physical networking into virtual switches, routers, and firewalls.	SDN, multi?tenant cloud networks.

Introduction to Virtualization

Model	What Is Virtualized?	Typical Scenarios
Hardware-Assisted Virtualization	Uses CPU extensions (Intel VT-x, AMD-V) to improve performance.	All modern hypervisors.

6. Key Technologies & Tools

Category	Popular Solutions
Hypervisors	VMware ESXi, Microsoft Hyper-V, KVM, Xen, Oracle VM

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