VIRTUALIZATION

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What is Virtualization ?

vir•tu•al (adj): existing in essence or effect, though not in actual fact

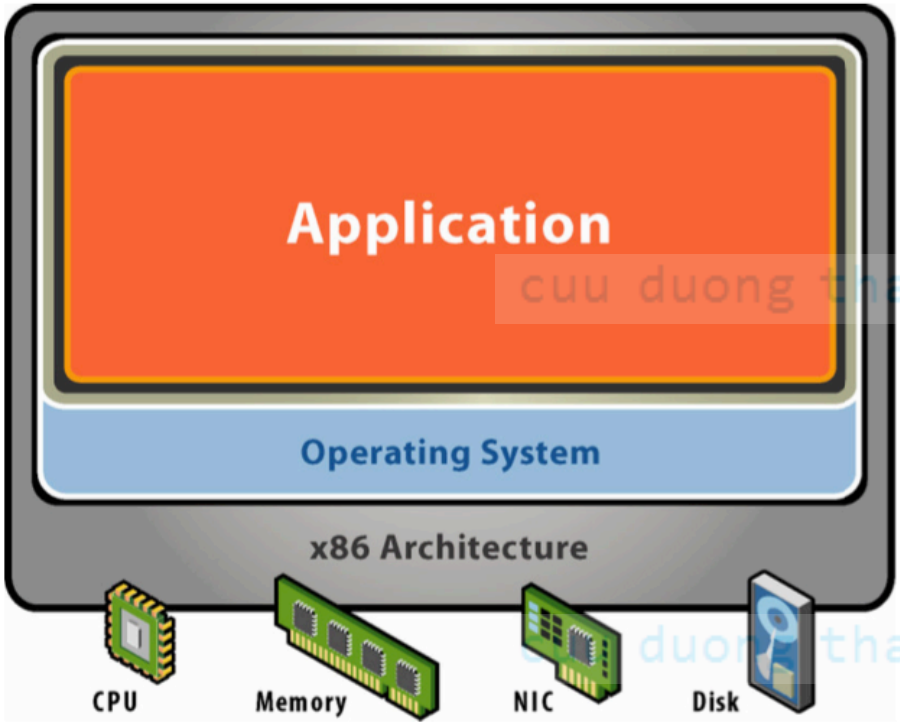
Virtual systems

- Abstract physical components using logical objects
- Dynamically bind logical objects to physical configurations

Examples

- Network – Virtual LAN (VLAN), Virtual Private Network (VPN)
- Storage – Storage Area Network (SAN), LUN
- Computer – Virtual Machine (VM), simulator

Starting Point: A Physical Machine



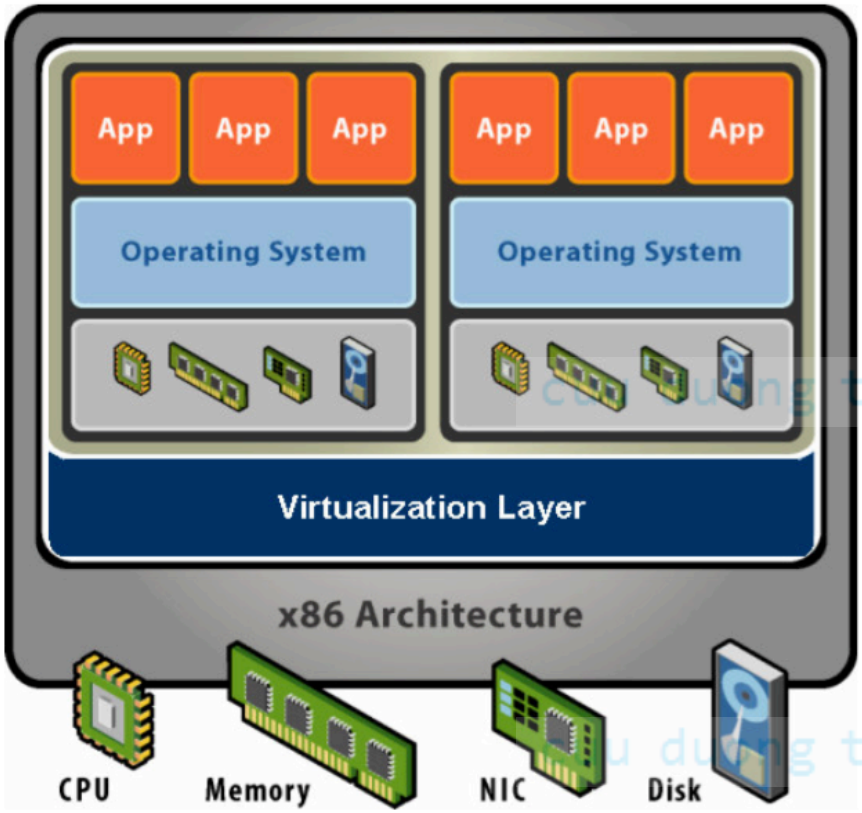
Physical Hardware

- Processors, memory, chipset, I/O bus and devices, etc.
- Physical resources often underutilized

Software

- Tightly coupled to hardware
- Single active OS image
- OS controls hardware

What is a Virtual Machine ?



Hardware-Level Abstraction

- Virtual hardware: processors, memory, chipset, I/O devices, etc.
- Encapsulates all OS and application state

Virtualization Software

- Extra level of indirection decouples hardware and OS
- Multiplexes physical hardware across multiple “guest” VMs
- Strong isolation between VMs
- Manages physical resources, improves utilization

VM Isolation

Secure Multiplexing

- Run multiple VMs on single physical host
- Processor hardware isolates VMs, *e.g.* MMU

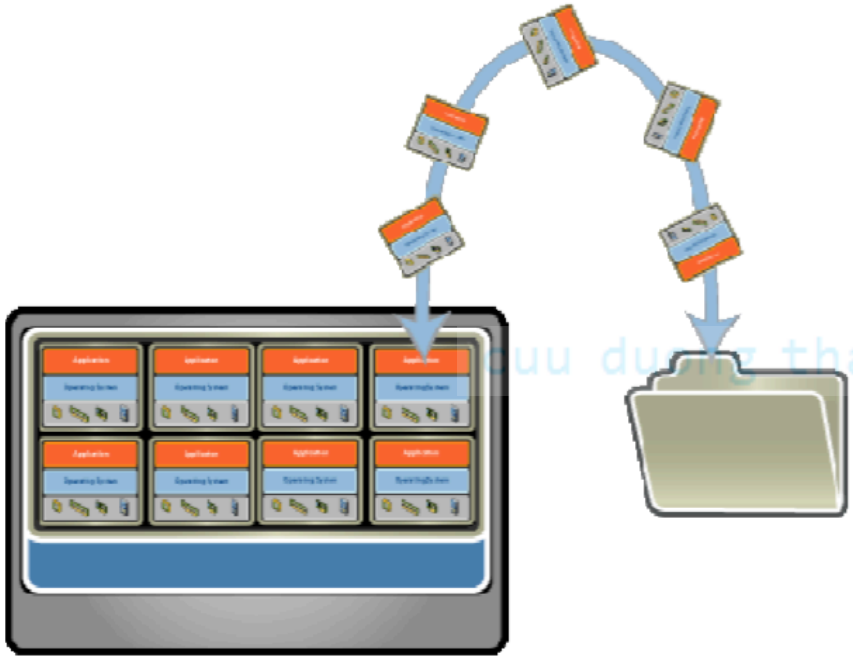
Strong Guarantees

- Software bugs, crashes, viruses within one VM cannot affect other VMs

Performance Isolation

- Partition system resources
- Example: VMware controls for reservation, limit, shares

VM Encapsulation



Entire VM is a File

- OS, applications, data
- Memory and device state

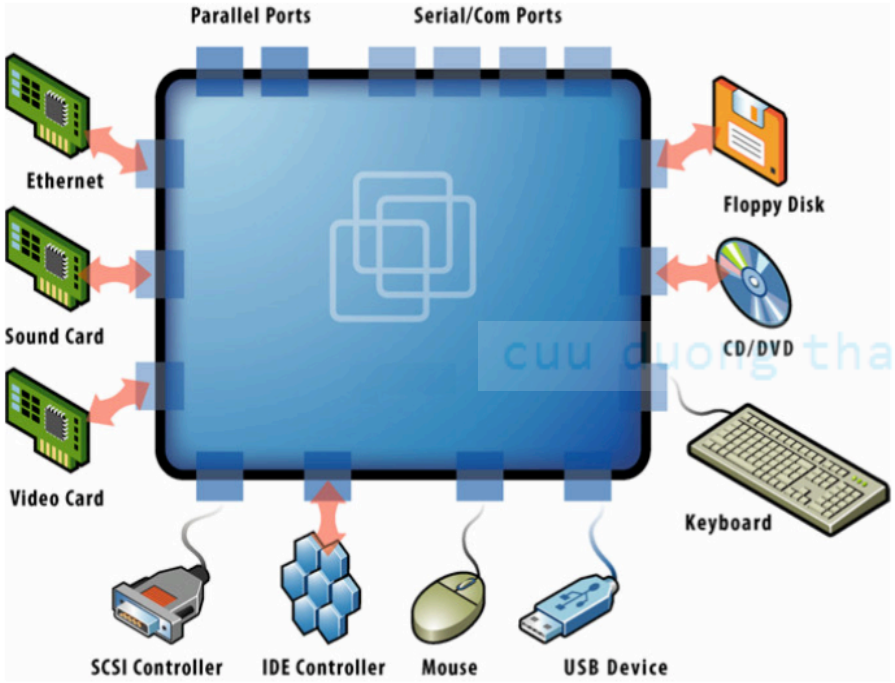
Snapshots and Clones

- Capture VM state on the fly and restore to point-in-time
- Rapid system provisioning, backup, remote mirroring

Easy Content Distribution

- Pre-configured apps, demos
- Virtual appliances

VM Compatibility



Hardware-Independent

- Physical hardware hidden by virtualization layer
- Standard virtual hardware exposed to VM

Create Once, Run Anywhere

- No configuration issues
- Migrate VMs between hosts

Legacy VMs

- Run ancient OS on new platform
- *E.g.* DOS VM drives virtual IDE and vLance devices, mapped to modern SAN and GigE hardware

Virtualization Comes in many forms

Virtual Memory — Each application sees its own logical **memory,** independent of physical memory

Virtual Networks — Each application sees its own logical **network,** independent of physical network

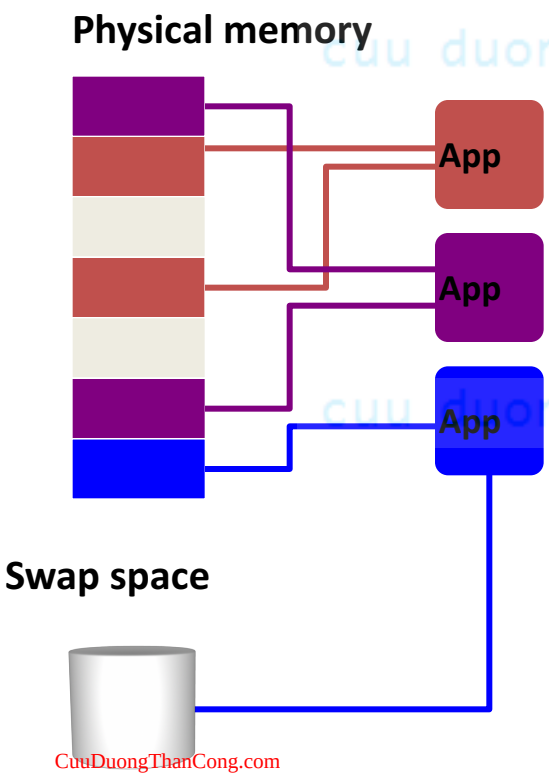
Virtual Servers — Each application sees its own logical **server,** independent of physical servers

Virtual Storage — Each application sees its own logical **storage,** independent of physical storage

Memory Virtualization

Virtual Memory

Each application sees its own logical **memory,** independent of physical memory



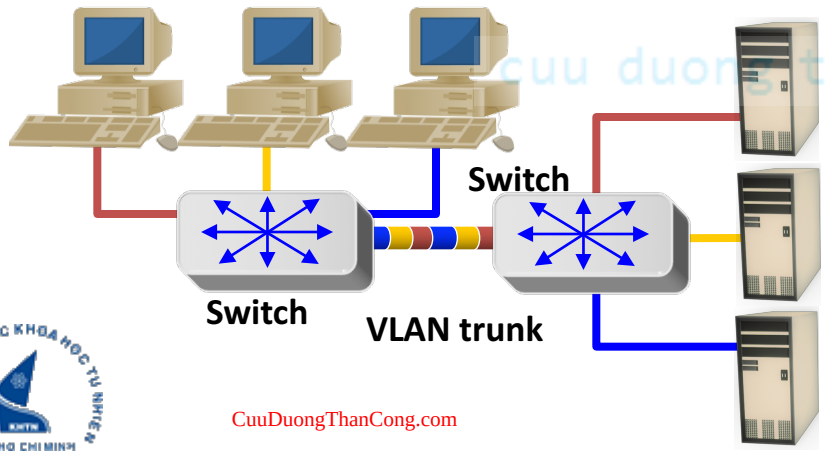
Benefits of Virtual Memory

- Remove physical-memory limits
- Run multiple applications at once

Network Virtualization

Virtual Networks

Each application sees its own logical **network,** independent of physical network

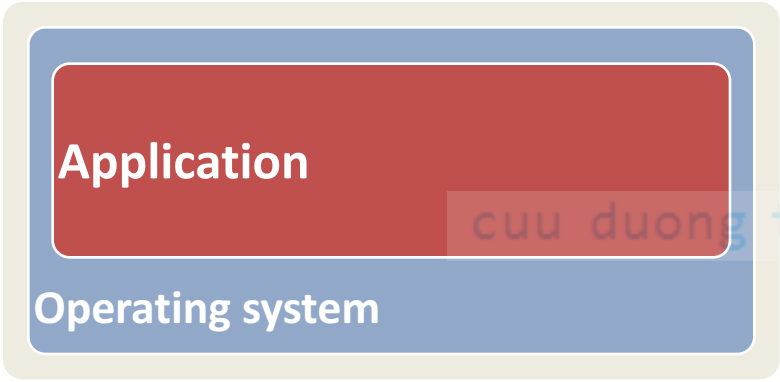


Benefits of Virtual Networks

- Common network links with access-control properties of separate links
- Manage logical networks instead of physical networks
- **Virtual SANs** provide similar benefits for storage-area networks

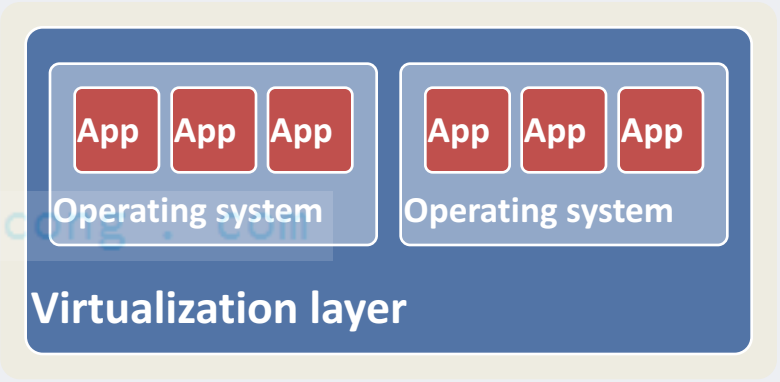
Server Virtualization

Before Server Virtualization:



- Single operating system image per machine
- Software and hardware tightly coupled
- Running multiple applications on same machine often creates conflict
- Underutilized resources

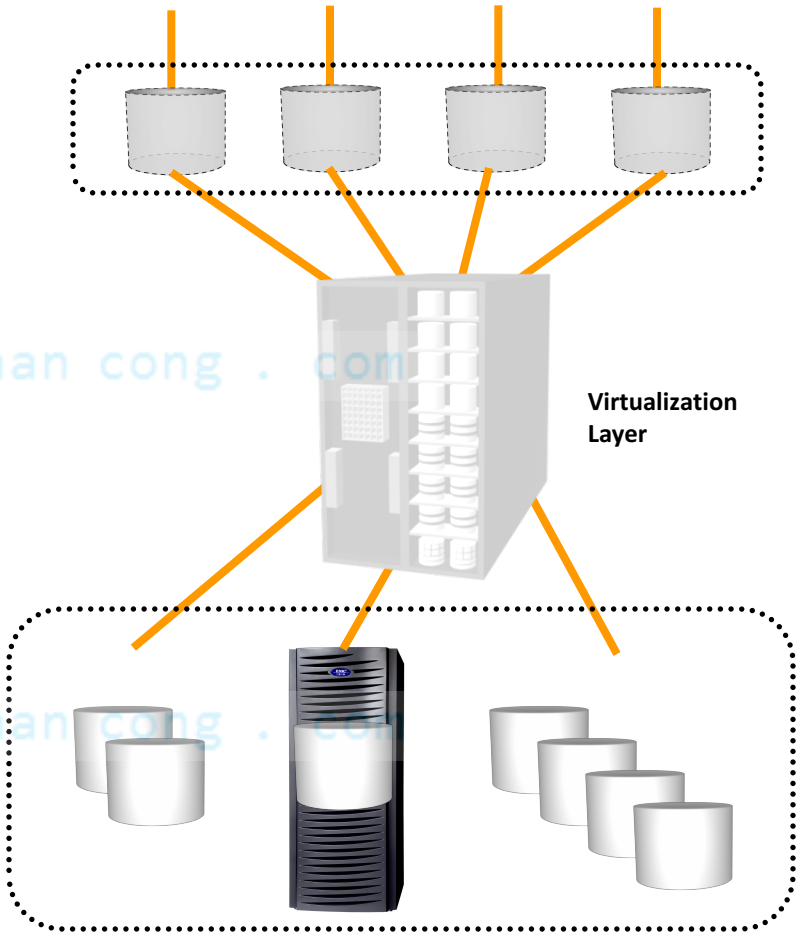
After Server Virtualization:



- Virtual Machines (VMs) break dependencies between operating system and hardware
- Manage operating system and application as single unit by encapsulating them into VMs
- Strong fault and security isolation
- Hardware-independent

Storage Virtualization

- Process of presenting a logical view of physical storage resources to hosts
- Logical storage appears and behaves as physical storage directly connected to host
- Examples of storage virtualization are:
  - Host-based volume management
  - LUN creation
  - Tape virtualization
- Benefits of storage virtualization:
  - Increased storage utilization
  - Adding or deleting storage without affecting application's availability
  - Non-disruptive data migration



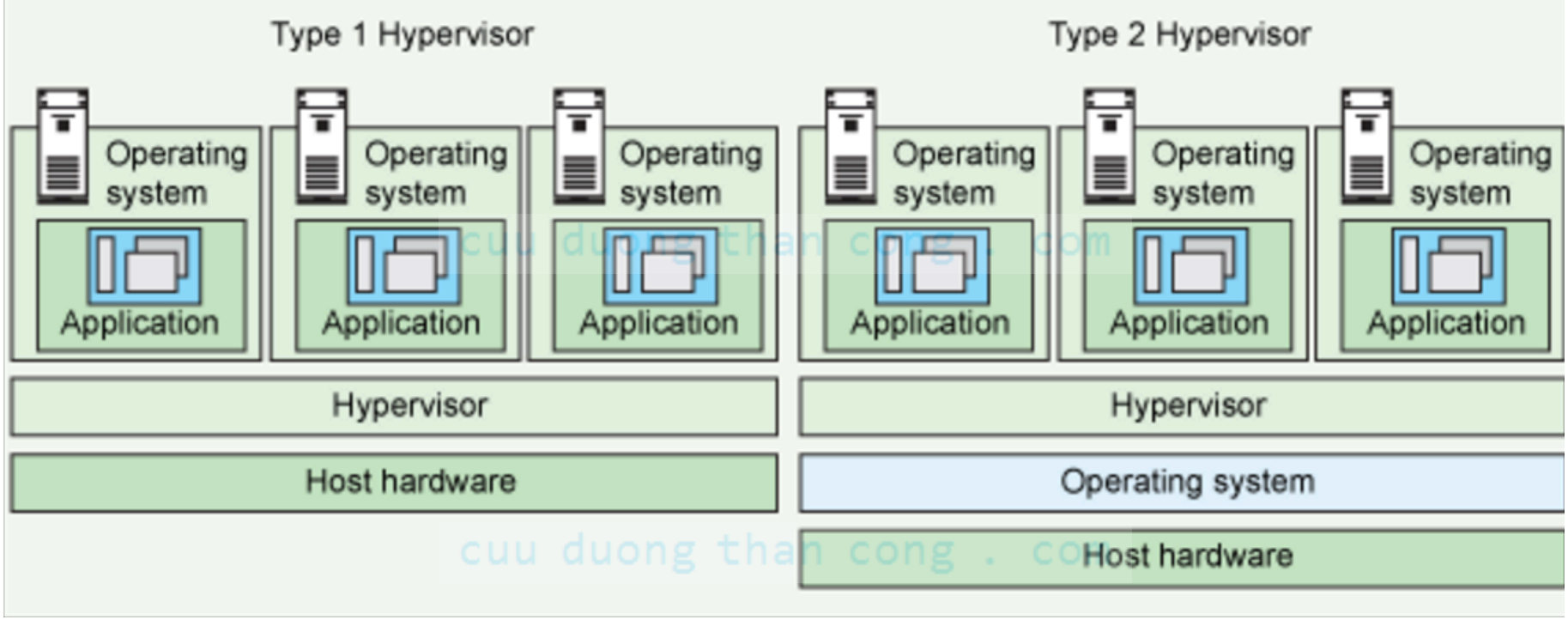
Desktop Virtualization

- Virtual Desktop Infrastructure (VDI) is a desktop delivery model which allows client desktop workloads (operating system, application, user data) to be hosted and executed on servers in the data center
- Users can communicate with their virtual desktops through a client device that supports remote desktop protocols such as RDP
- This allows you to virtualize Windows desktops in the datacenter and deliver them on demand to any user — anywhere

Hypervisor

- A **hypervisor** or **virtual machine monitor** (**VMM**) is a piece of computer software, firmware or hardware that creates and runs virtual machines.
- Two major types:
  - Type-I
  - Type-II

Hypervisor

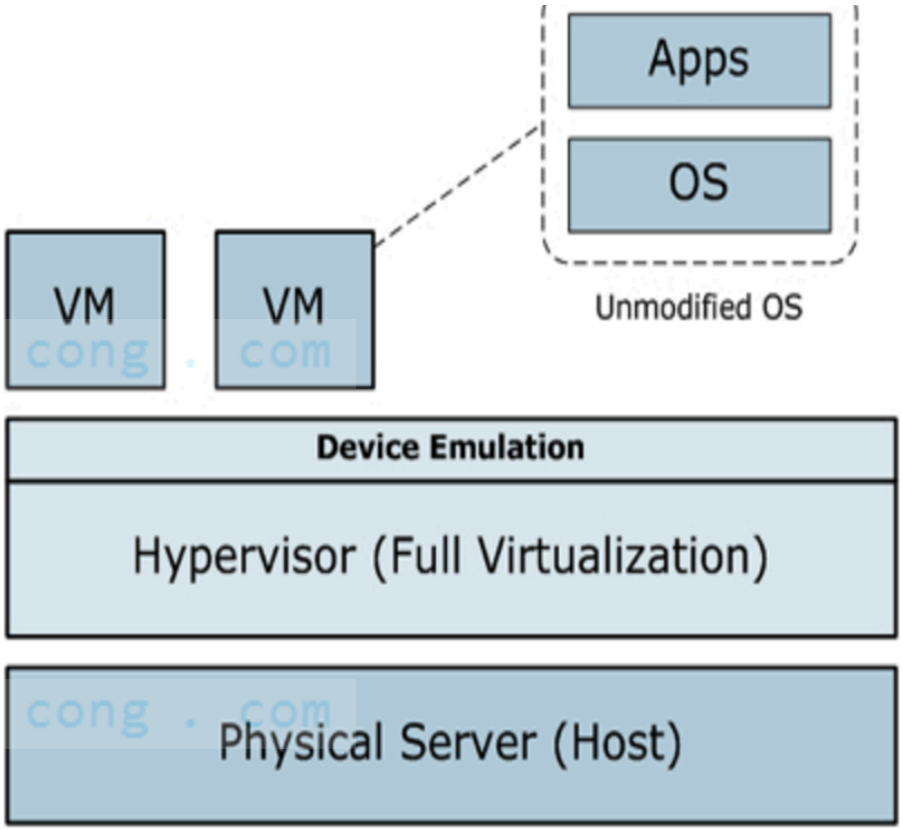

Type 1 Hypervisor
Type 2 Hypervisor
Operating system
Application
Hypervisor
Host hardware
Operating system
Application
Hypervisor
Operating system
Host hardware

Hardware Virtualization Techniques

- CPU installed on the host is only one set, but each VM that runs on the host requires their own CPU
- It means CPU needs to virtualized, done by hypervisor

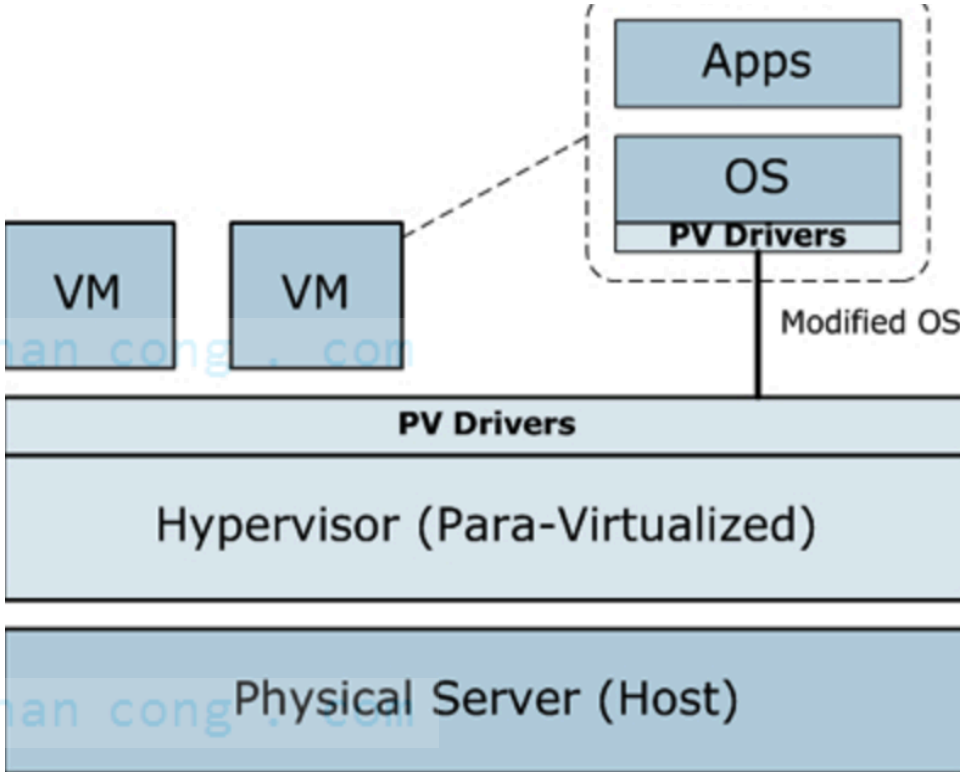
Full virtualization

- Ability to run program (OS) directly on top of a VM and without any modification
- Advantages:
  - Complete isolation
  - Enhanced security
  - Easy of emulation of different architectures and coexistence.



Paravirtualization

- Not-transparent virtualization
- Guest OS need to be modified
- Simply transfer the execution of instructions which were hard to virtualized, directly to the host.

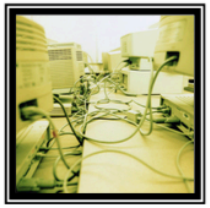


Common Virtualization Uses

Test and Development – Rapidly provision test and development servers; store libraries of pre-configured test machines

Server Consolidation and Containment – Eliminate server sprawl by deploying systems into virtual machines that can run safely and move transparently across shared hardware

Business Continuity – Reduce cost and complexity by encapsulating entire systems into single files that can be replicated and restored onto any target server



Enterprise Desktop – Secure unmanaged PCs without compromising end-user autonomy by layering a security policy in software around desktop virtual machines

Q&A

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