Advanced Computer Network:

Virtualization

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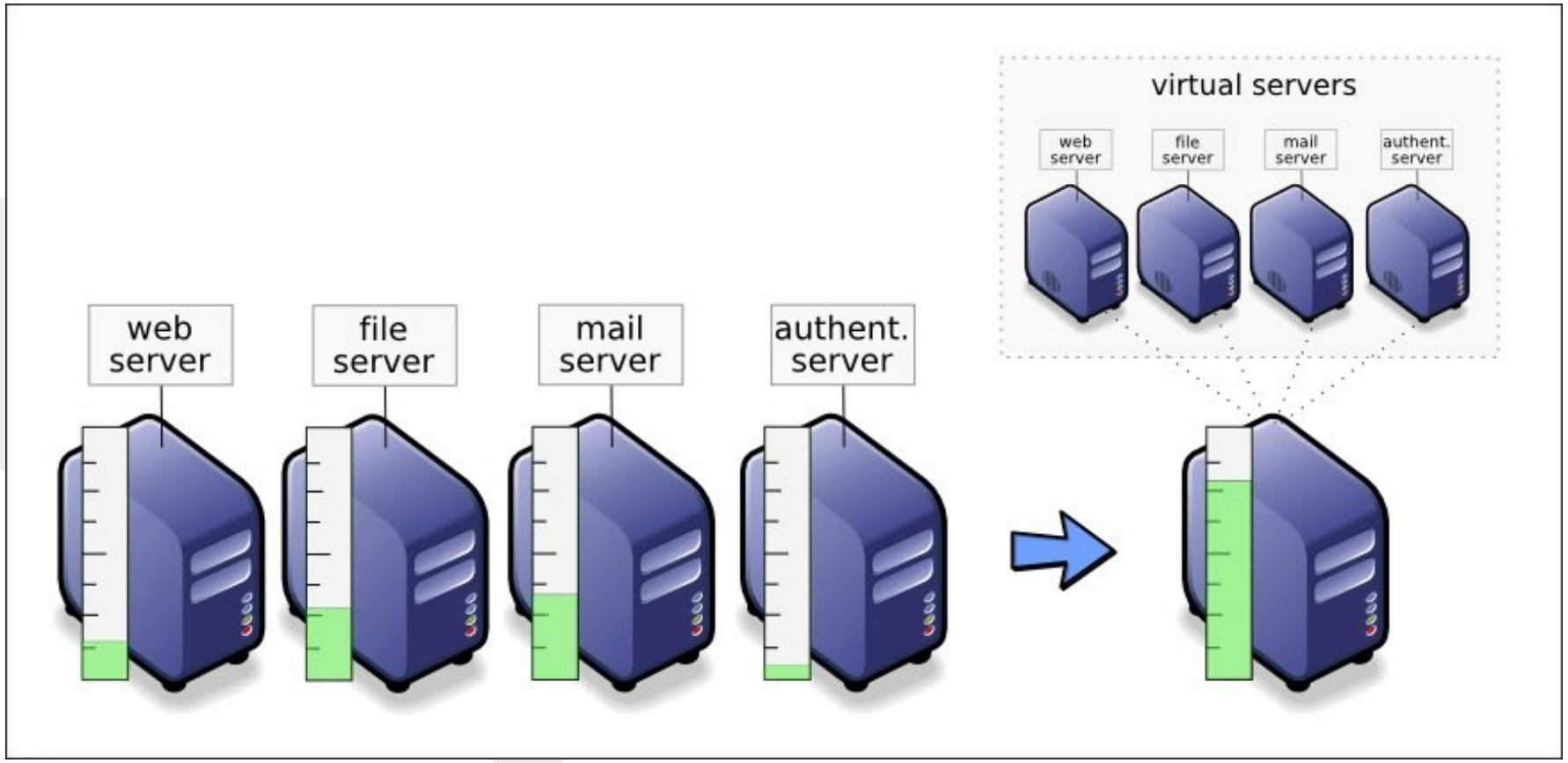
Definisi

In computing, **virtualization** refers to the act of creating a virtual (rather than actual) version of something, including virtual computer hardware platforms, storage devices, and computer network resources.

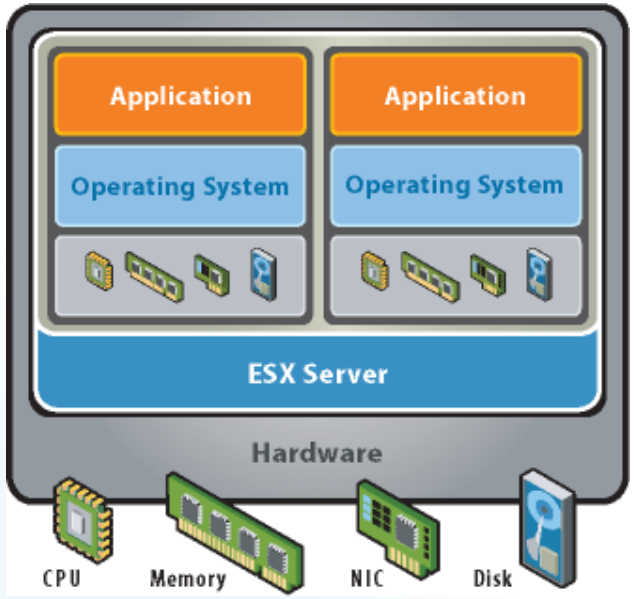
Alasan penggunaan Virtualization (1)



Alasan penggunaan Virtualization (2)

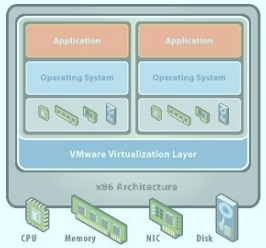
- Pengurangan biaya pemeliharaan
- Kompatibilitas dengan aplikasi dan OS bawaan
- Security: isolasi untuk aplikasi tertentu
- Lingkungan pengembangan (dev env) yg murah
- Manajemen terpusat
- Proses backup yg mudah
- Live migration
- Quick server fail-over
- HA
- Virtual Applience
- Cloud Computing

Teknologi utama Virtualization



- Partitioning
  - Run multiple operating systems on one physical machine
  - Divide system resources between virtual machines

Teknologi utama Virtualization



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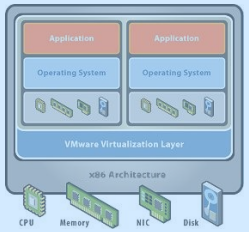
- Isolation
  - Fault and security isolation at the hardware level
  - Advanced resource controls preserve performance

Teknologi utama Virtualization



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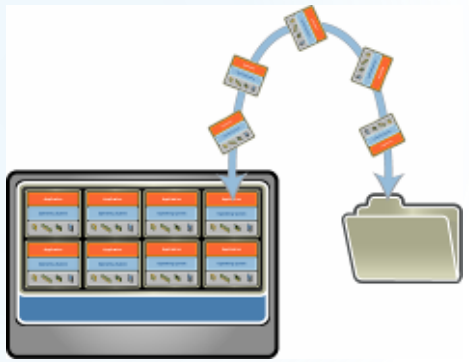
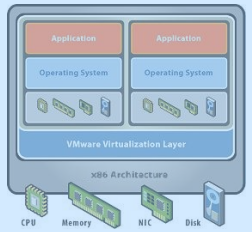


- Encapsulation
  - Entire state of the virtual machine can be saved to files
  - Move and copy virtual machines as easily as moving and copying files

Teknologi utama Virtualization



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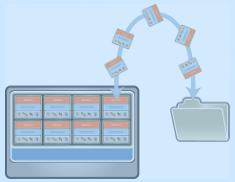

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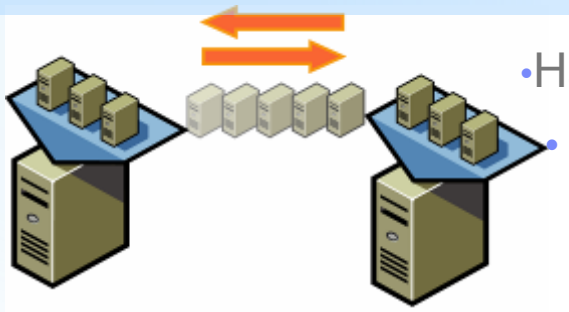
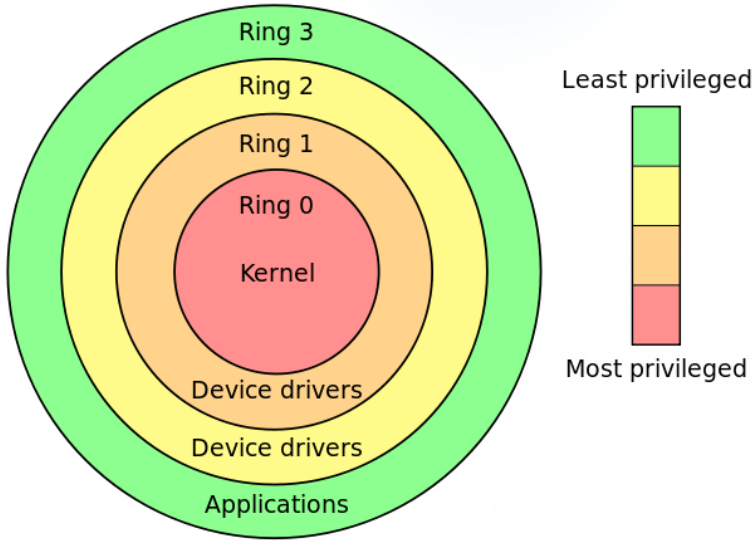


- Hardware-Independence
  - Provision or migrate any virtual machine to any similar or different physical server

Hypervisor
Terminologi

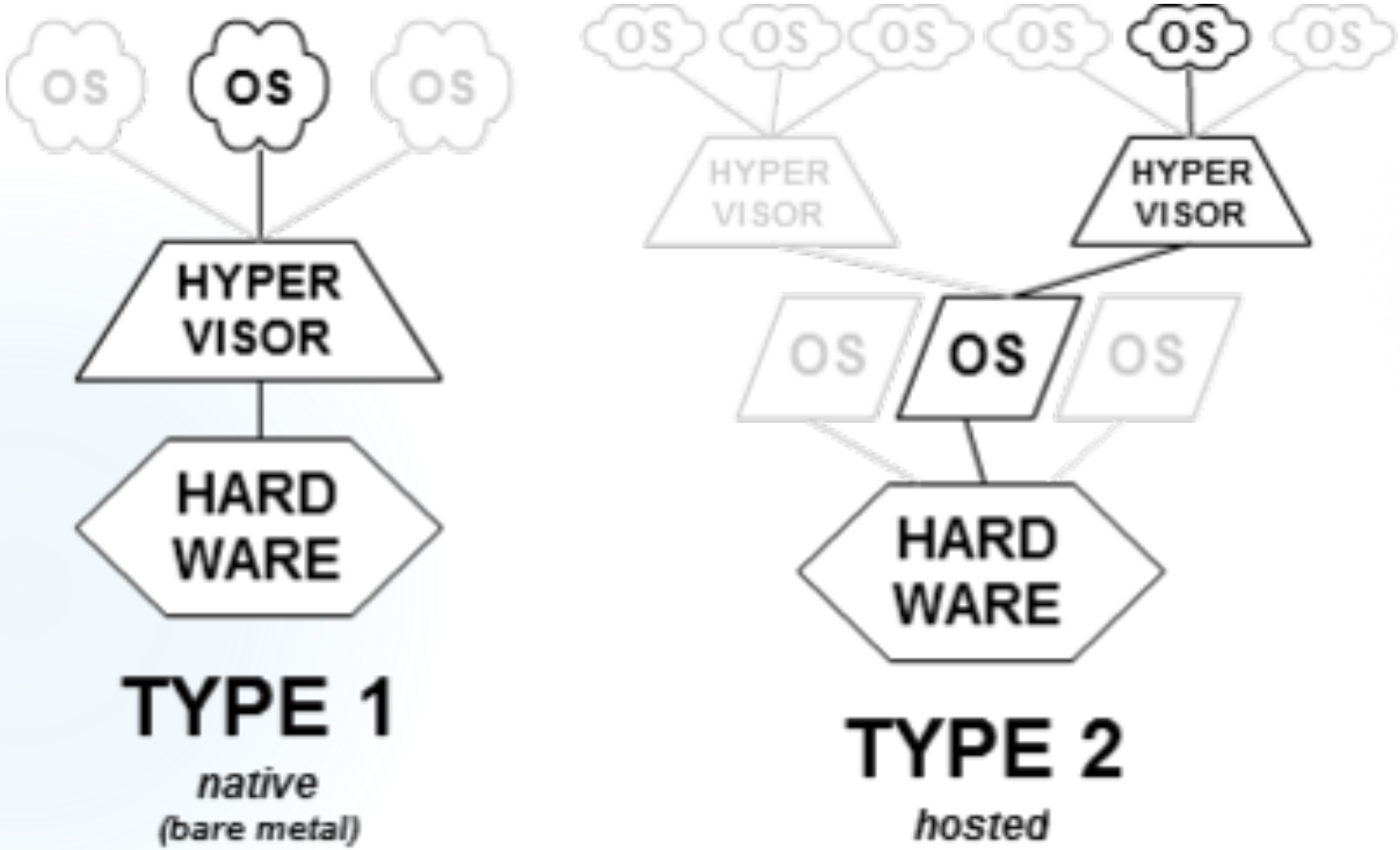


- Sejarah
  - 1967, 1972, 1987 → IBM mainframe
  - 2000 → Sun Microsystem, VMware
- Protection Ring
  - Mekanisme OS untuk melindungi data dari fault dan malicious behaviour
  - Menggunakan level privillages
  - Mode
    - Supervisor / User mode
    - Hypervisor

Hypervisor
Terminologi (2)

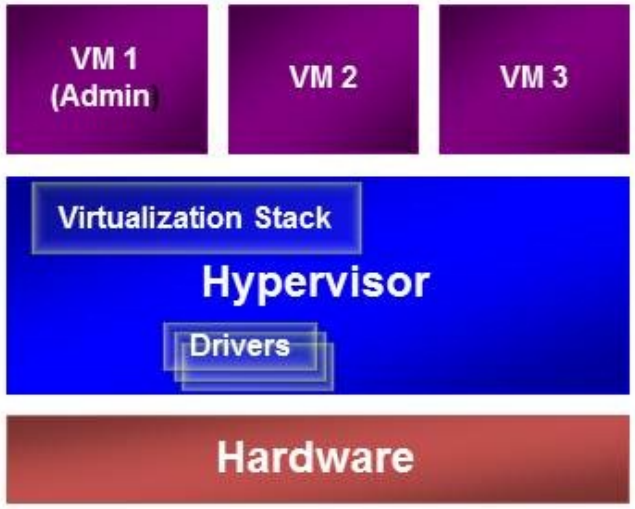
- Hypervisor / Virtual Machine Monitor (VMM)
  - Perangkat lunak, firmware atau perangkat keras yang dapat membangun virtual machine.
- Jenis mesin (machine)
  - Host machine → komputer yang memiliki hypervisor dan menjalankan virtual machine
  - Guest machine / virtual machine (VM) → komputer virtual yang dijalankan di host machine

Classification Hypervisor



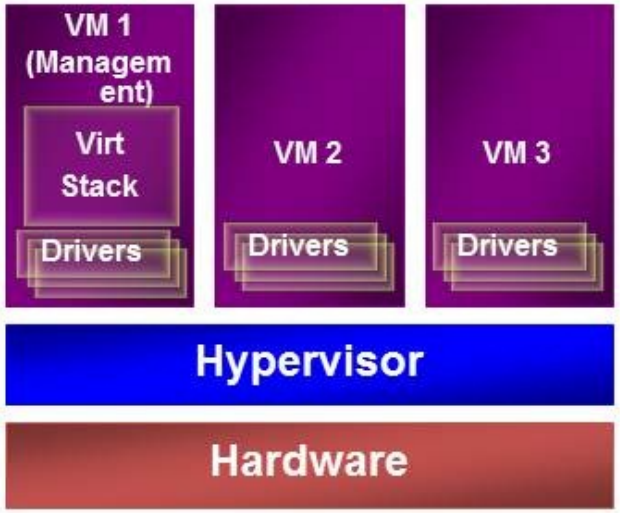
Classification Hypervisor Type 1

- Monolithic Hypervisor



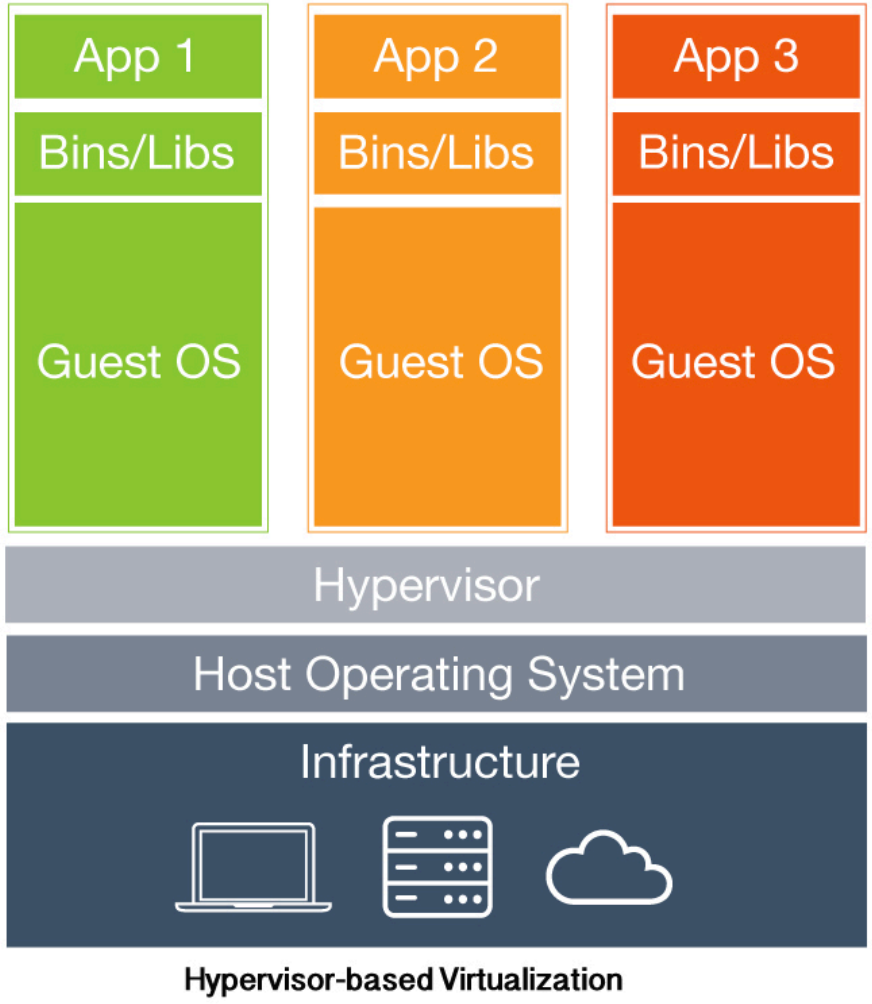
- Implements a proprietary driver model within the hypervisor
- More simple than a modern kernel, but still complex

- Microkernel Hypervisor

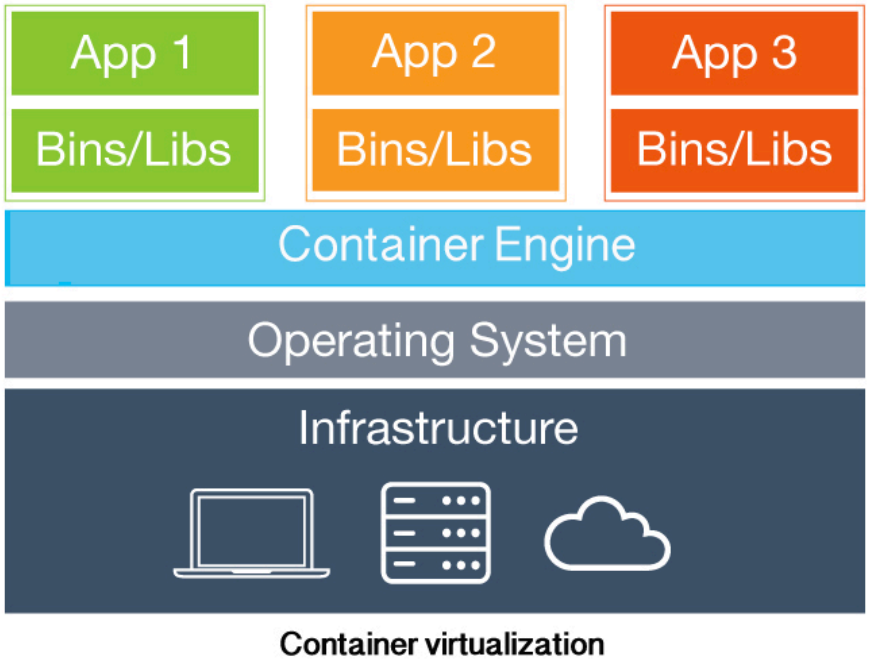


- Simple partitioning functionality
- Increases reliability and minimizes attack surface
- No third-party code (drivers run within VMs)

Jenis Virtualization

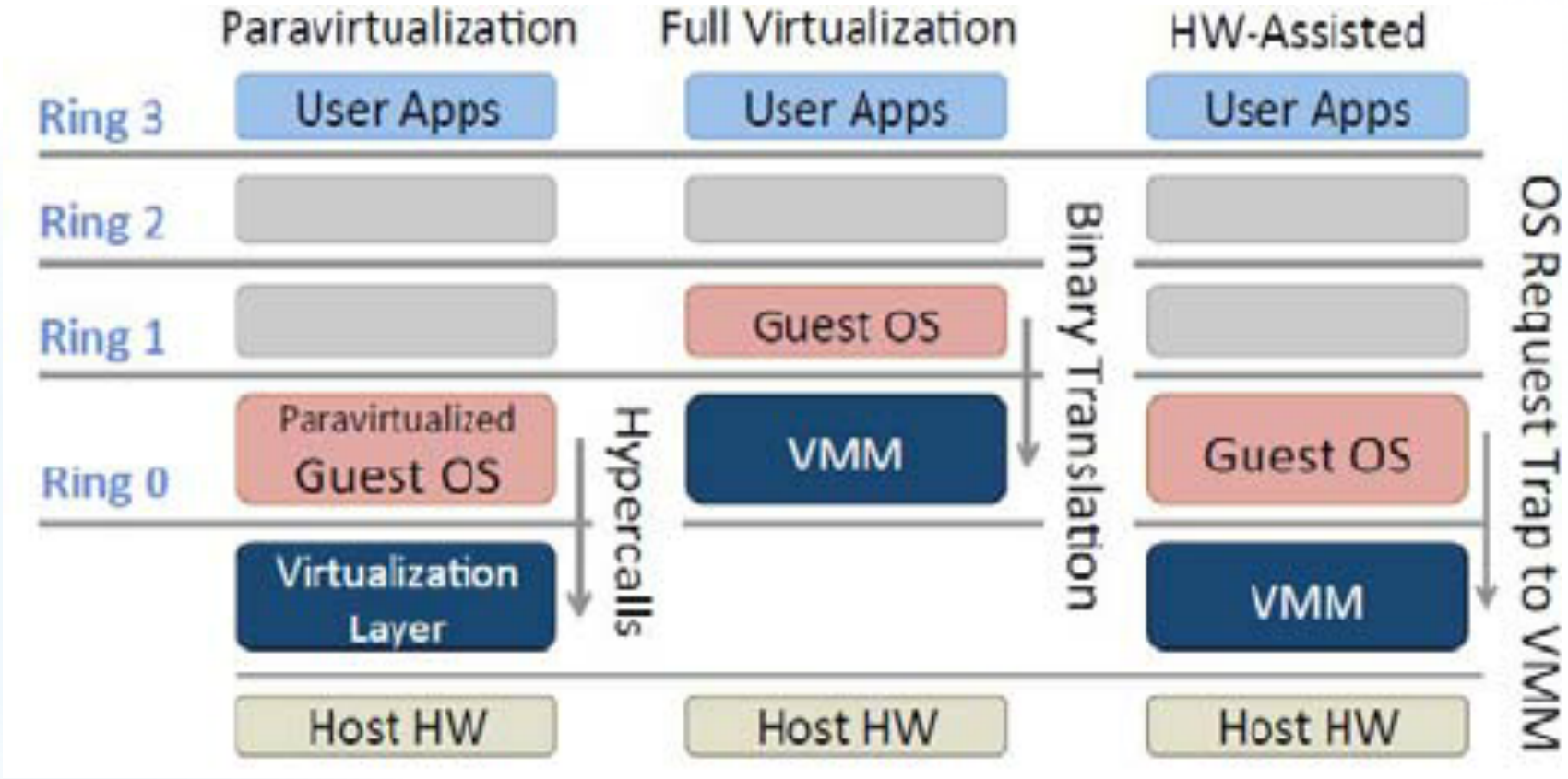


Hypervisor-based Virtualization



Container virtualization

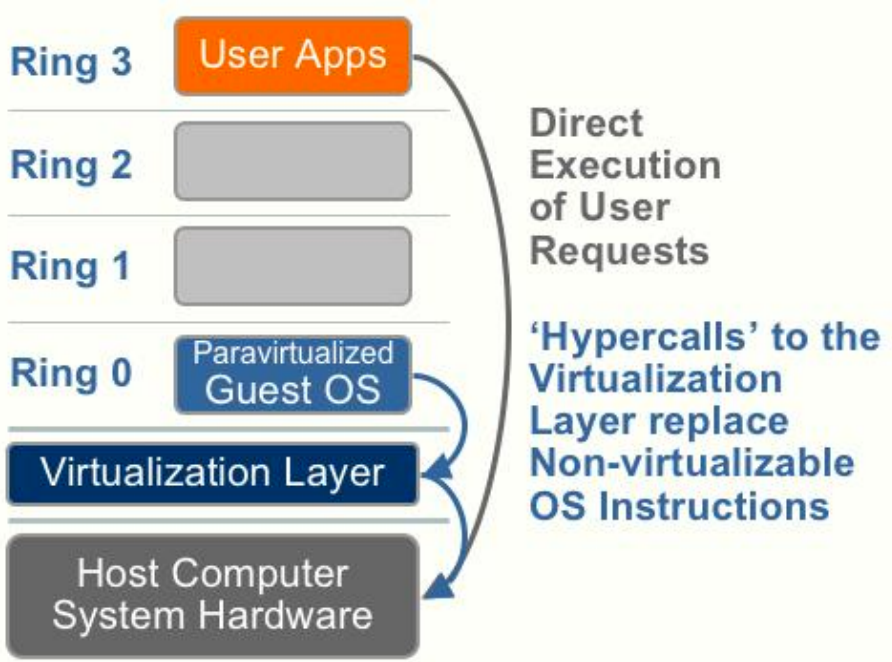
Teknologi Virtualization berbasis Hypervisor



Teknologi Virtualization

OS assisted virtualization / paravirtualization

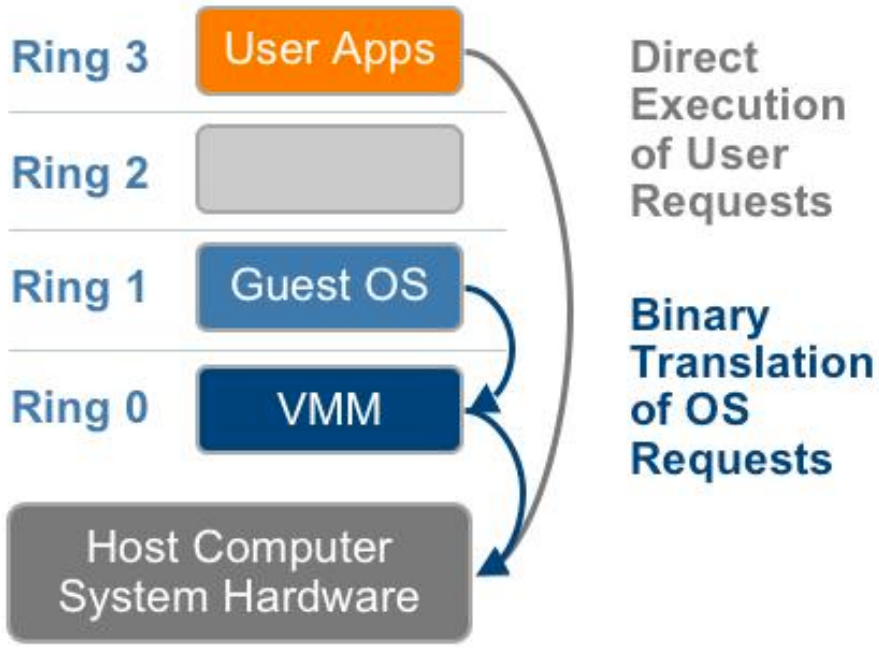
- Teknik yg ringan
- Hypervisor memberikan API dan digunakan guest machine dengan memodifikasi OS
- Tidak memerlukan virtualization extension dari host machine



Teknologi Virtualization

Full Virtualization

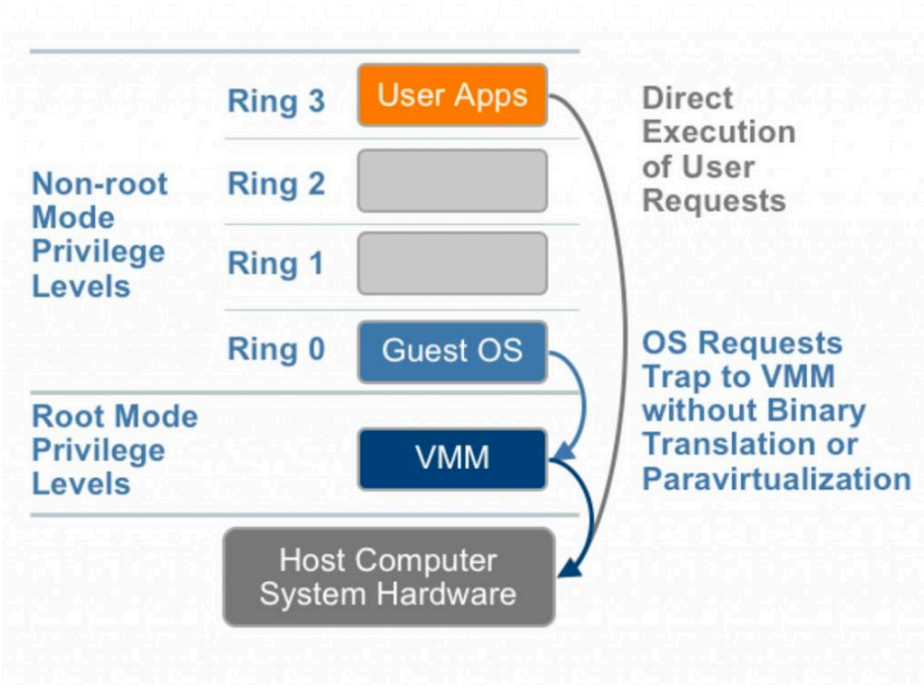
- Di handle oleh VMM
- Guest machine seamless
- Tidak memerlukan modifikasi perangkat keras



Teknologi Virtualization

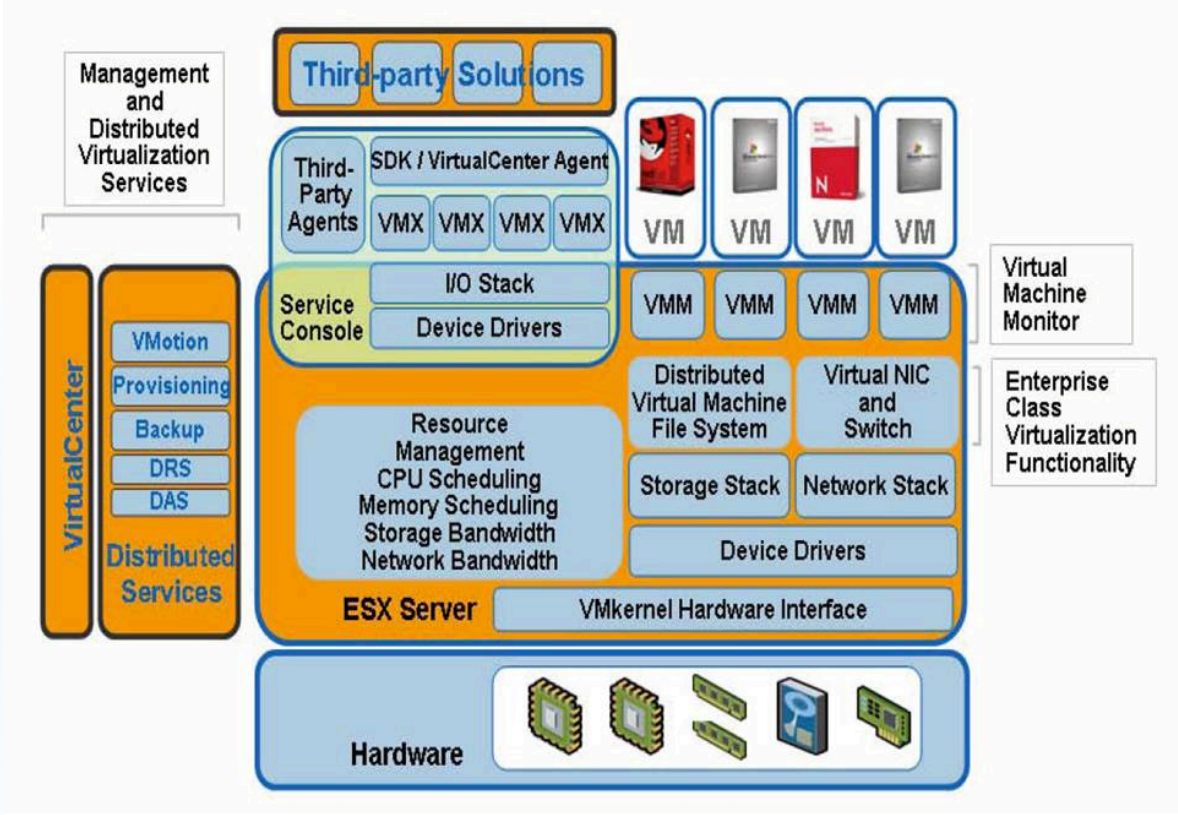
Hardware Assisted Virtualization

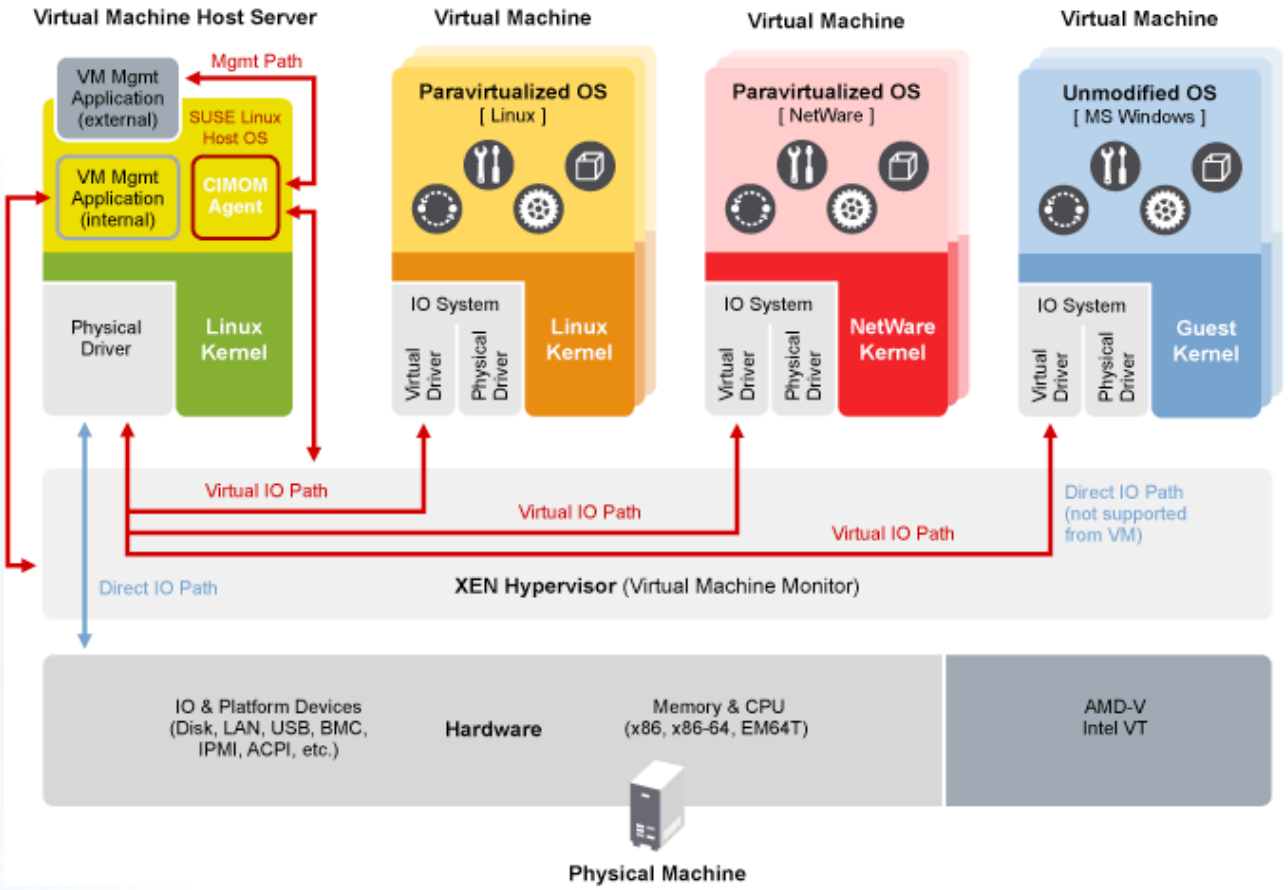
- Full virtualization yang didukung perangkat keras
- Guest OS tidak perlu dimodifikasi
- Hypervysor melakukan trap
- Contoh:
  - Intel VT-x
  - AMD-V



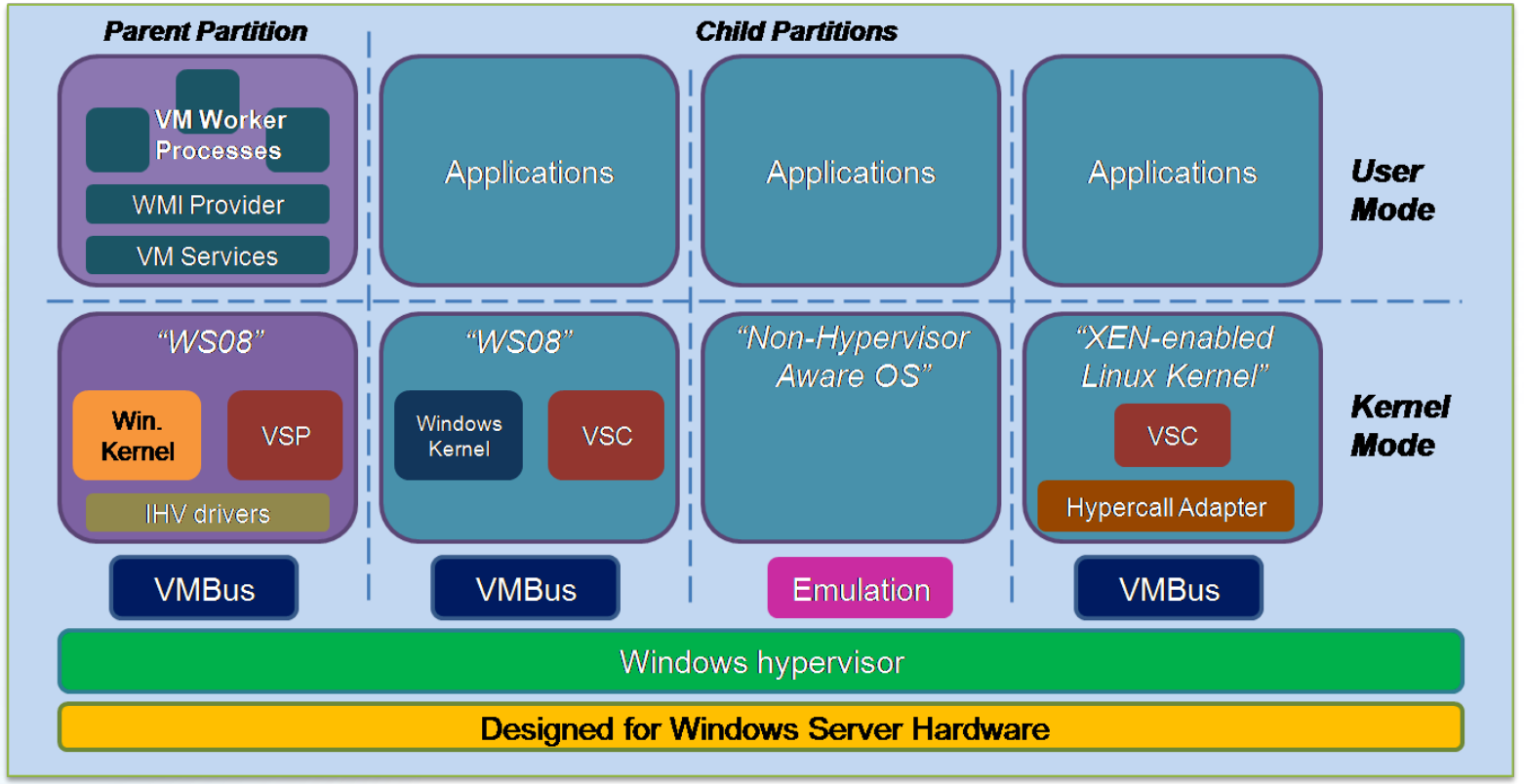
Teknologi Virtualization
Perbandingan

	PARA VIRTUALIZATION	FULL VIRTUALIZATION	HARDWARE ASSISTED
Teknik	Hypercall	Direct Execution	Exit to root mode on privileged instruction
Guest OS modifikasi	Guest OS dimodifikasi untuk dapat menjalankan hypercall	Tidak dimodifikasi	Tidak dimodifikasi
Performasi	Lebih baik di beberapa kasus	baik	cukup
Contoh	VMware, xen	VMware, Microsoft, KVM	VMware, xen, microsoft, parallel
Ketergantungan hypersor pada Guest OS	XenLinux hanya jalan di hypersor xen	ya	ya


Management and Distributed Virtualization Services
Third-party Solutions
Third-Party Agents
SDK / VirtualCenter Agent
VMX
VMX
VMX
VMX
VM
VM
VM
VM
Service Console
I/O Stack
Device Drivers
VMM
VMM
VMM
VMM
Virtual Machine Monitor
VirtualCenter
VMotion
Provisioning
Backup
DRS
DAS
Distributed Services
Distributed Virtual Machine File System
Virtual NIC and Switch
Enterprise Class Virtualization Functionality
Resource Management
CPU Scheduling
Memory Scheduling
Storage Bandwidth
Network Bandwidth
Storage Stack
Network Stack
Device Drivers
ESX Server
VMkernel Hardware Interface
Hardware

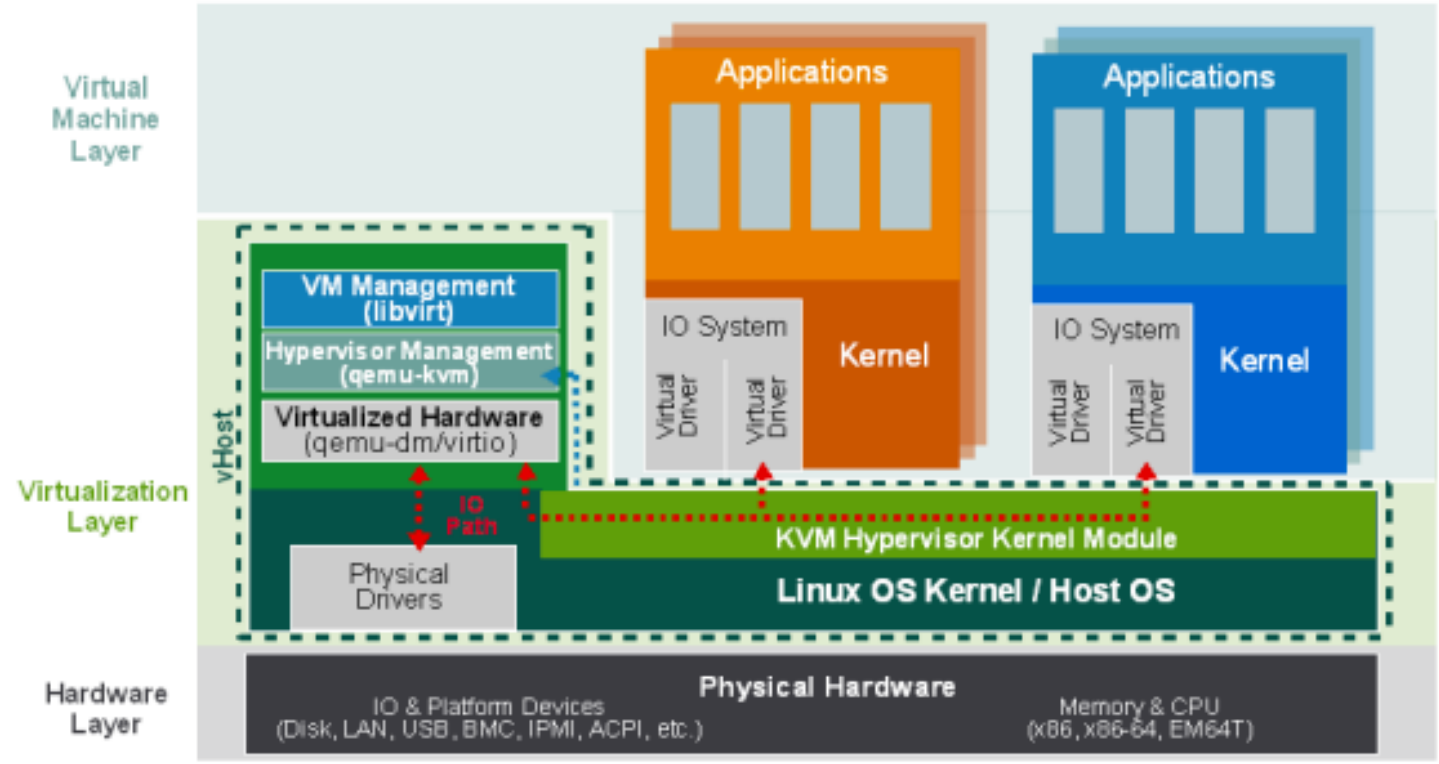

Virtual Machine Host Server
Virtual Machine
Virtual Machine
Virtual Machine
Mgmt Path
VM Mgmt Application (external)
SUSE Linux Host OS
VM Mgmt Application (internal)
CIMOM Agent
Physical Driver
Linux Kernel
Paravirtualized OS [Linux]
IO System
Virtual Driver
Physical Driver
Linux Kernel
Paravirtualized OS [NetWare]
IO System
Virtual Driver
Physical Driver
NetWare Kernel
Unmodified OS [MS Windows]
IO System
Virtual Driver
Physical Driver
Guest Kernel
Virtual IO Path
Virtual IO Path
Virtual IO Path
Direct IO Path (not supported from VM)
Direct IO Path
XEN Hypervisor (Virtual Machine Monitor)
IO & Platform Devices (Disk, LAN, USB, BMC, IPMI, ACPI, etc.)
Hardware
Memory & CPU (x86, x86-64, EM64T)
AMD-V Intel VT
Physical Machine

Microsoft Hyper-V



Detailed architecture of Windows Server virtualization

KVM

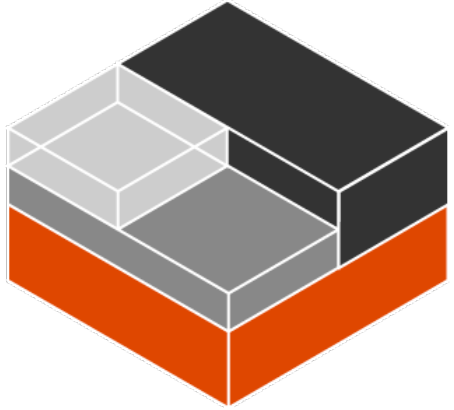

Virtual Machine Layer
Virtualization Layer
Hardware Layer
Applications
Applications
IO System
Kernel
Virtual Driver
Virtual Driver
IO System
Kernel
Virtual Driver
Virtual Driver
vHost
VM Management (libvirt)
Hypervisor Management (qemu-kvm)
Virtualized Hardware (qemu-dm/virtio)
IO Path
Physical Drivers
KVM Hypervisor Kernel Module
Linux OS Kernel / Host OS
Physical Hardware
IO & Platform Devices (Disk, LAN, USB, BMC, IPMI, ACPI, etc.)
Memory & CPU (x86, x86-64, EM64T)

Penggunaan

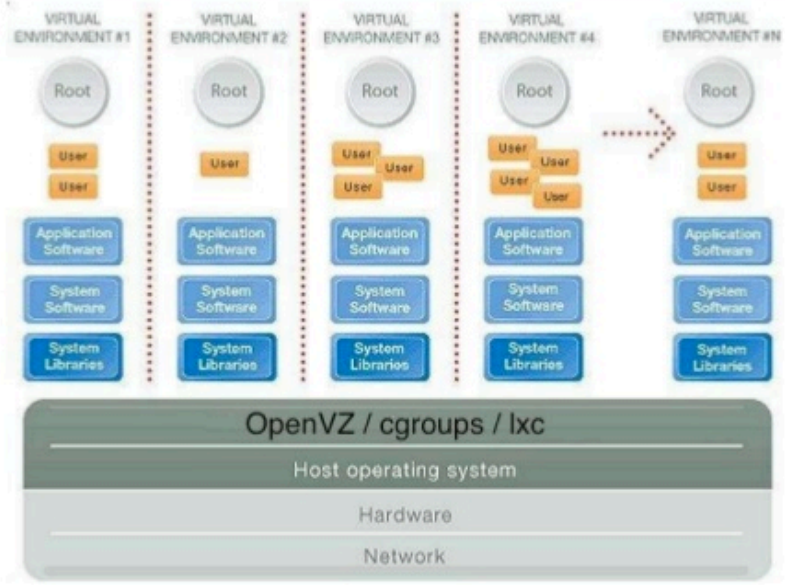
- Virtual Private Server (VPS)
  - Amazon Elastic Compute Cloud (EC2)
    - Xen
  - Microsoft Azure
    - Microsoft Hyper-V
  - Google Compute Engine (GCE)
    - KVM
  - Rackspace
    - VMware

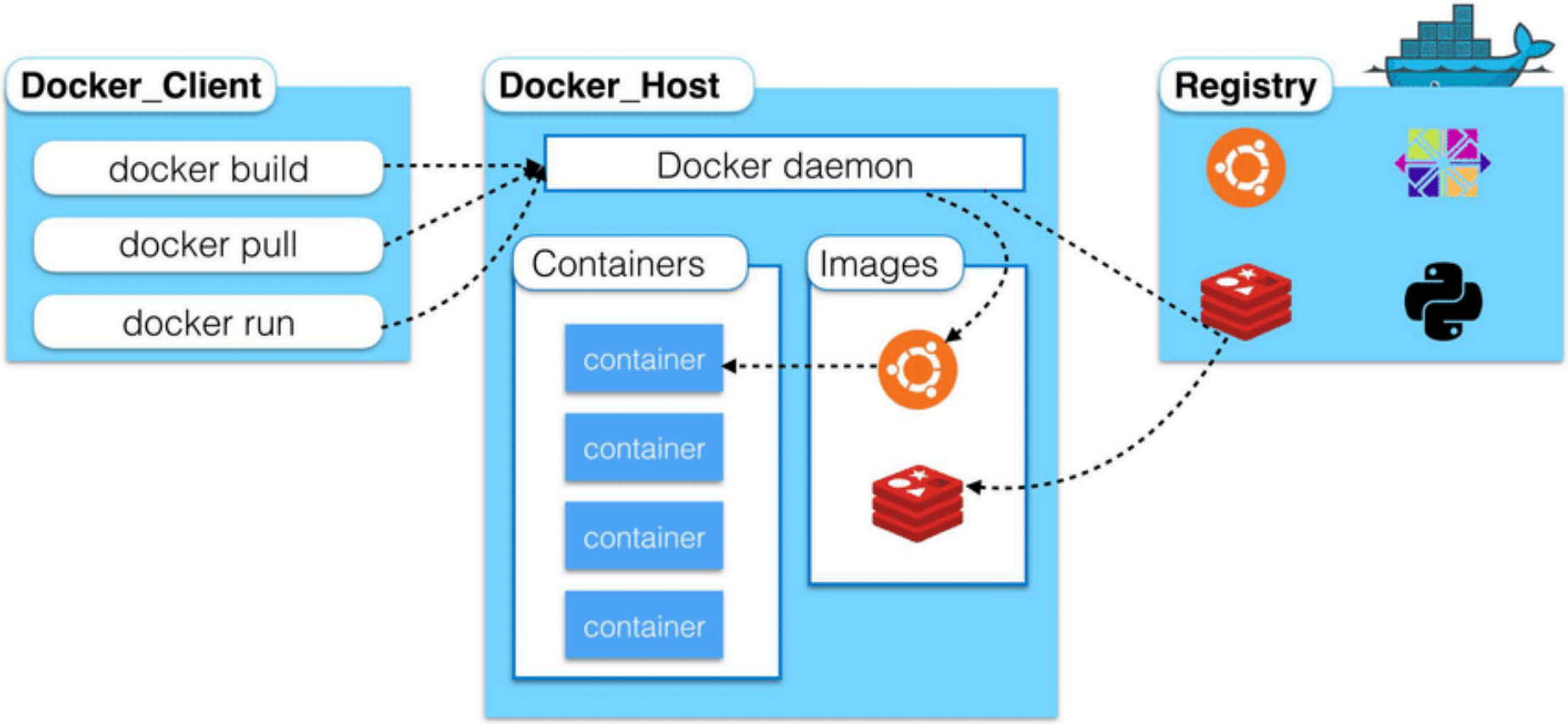
Teknologi Virtualization berbasis Container

- Operating-system-level virtualization / Containerization
  - Fitur sistem operasi yang mampu membuat isolasi user-space di host machine.
  - Contoh
    - Linux Container
    - Docker

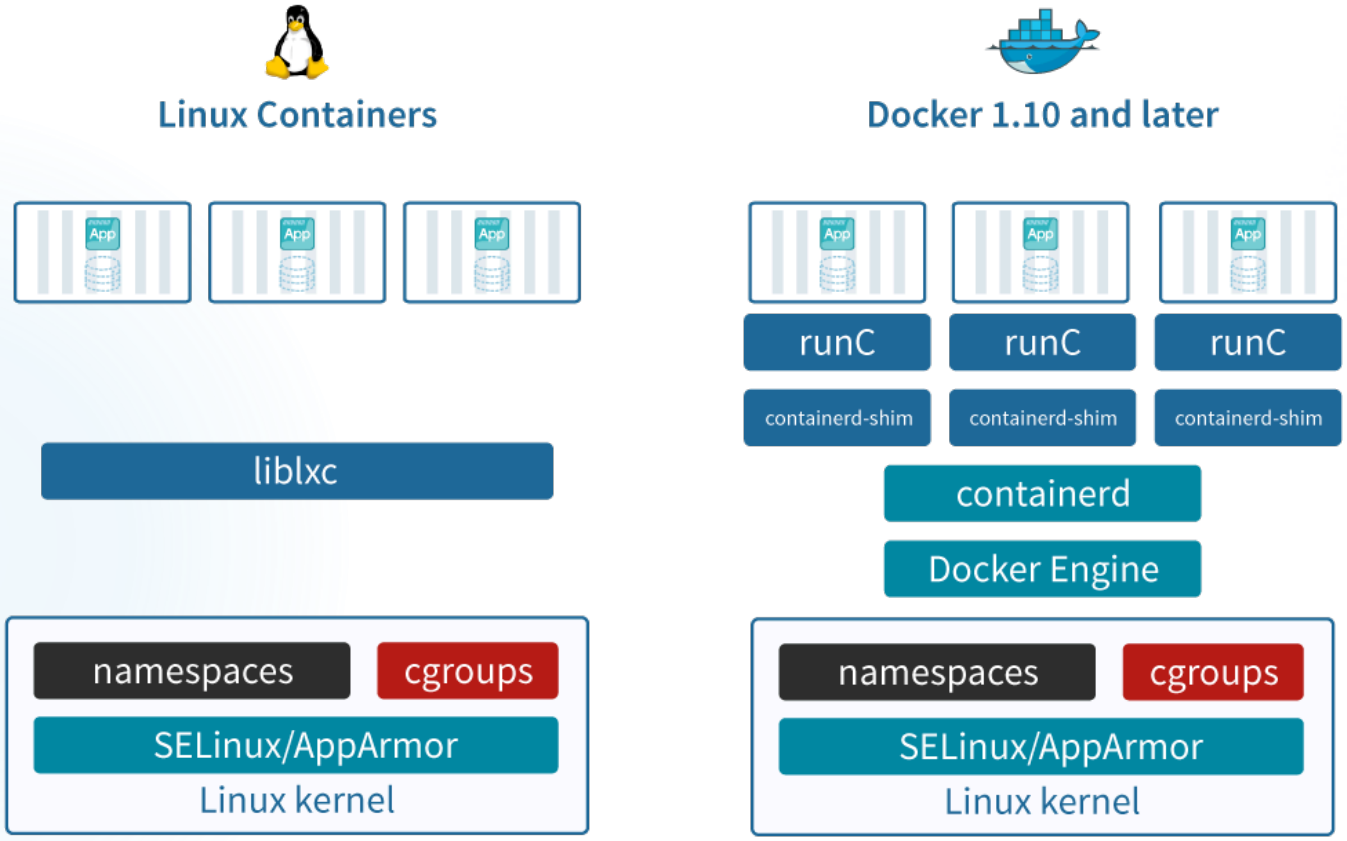


LinuX Containers, LXC architecture

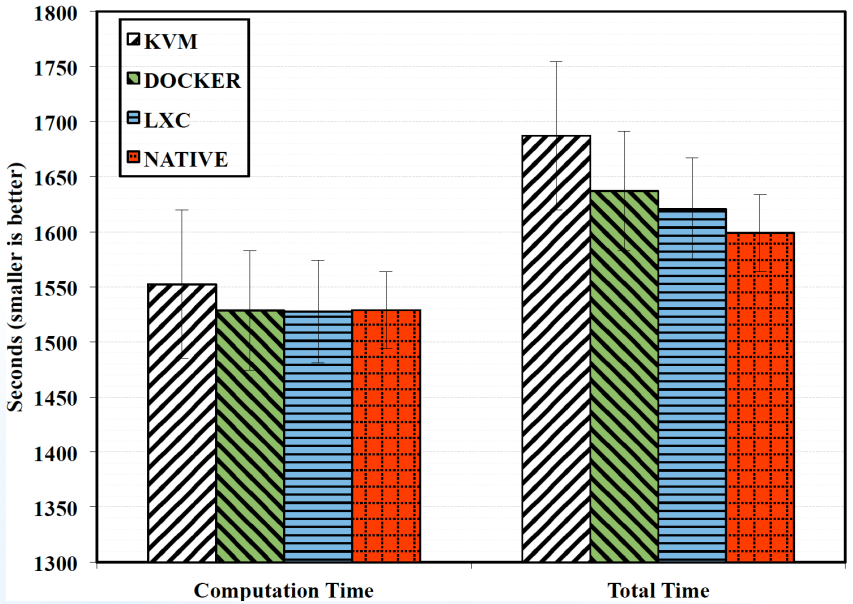



Docker_Client
docker build
docker pull
docker run
Docker_Host
Docker daemon
Containers
container
container
container
container
Images
Registry

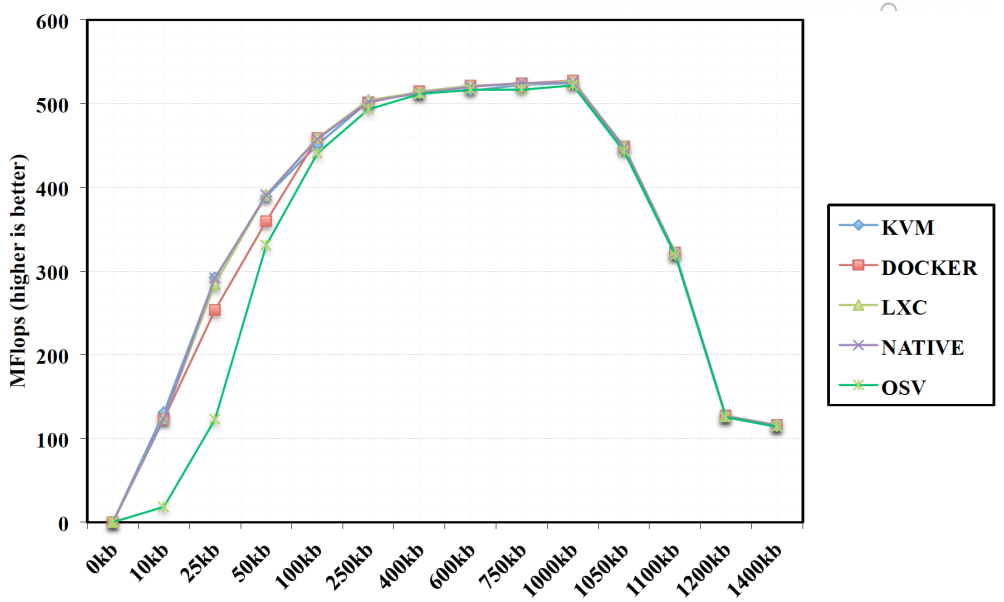
Teknologi Virtualization berbasis Container - Perbandingan

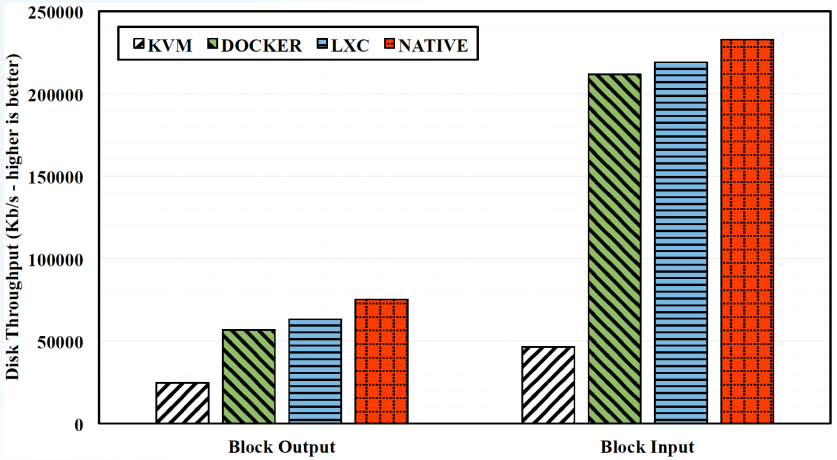


Performasi



Platform	Multi-core Efficiency
Native	98.27%
LXC	98.19%
Docker	98.16%
KVM	97.51%





Referensi

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- https://en.wikipedia.org/wiki/Hardware_virtualization
- https://en.wikipedia.org/wiki/Operating-system-level_virtualization
- Morabito, Roberto, Jimmy Kjällman, and Miika Komu. "Hypervisors vs. lightweight virtualization: a performance comparison." *Cloud Engineering (IC2E), 2015 IEEE International Conference on*. IEEE, 2015.