



Virtualization and Hypervisor

Tuul Triyason, Ph.D.

School of Information
Technology, KMUTT

Bangkok, Thailand

A Definition

Virtualization is a way to abstract applications and their underlying components away from the hardware supporting them and present a logical or virtual view of these resources. This virtual view is constructed using excess processing power, memory, storage, or network bandwidth.



Factors that drive a virtualization

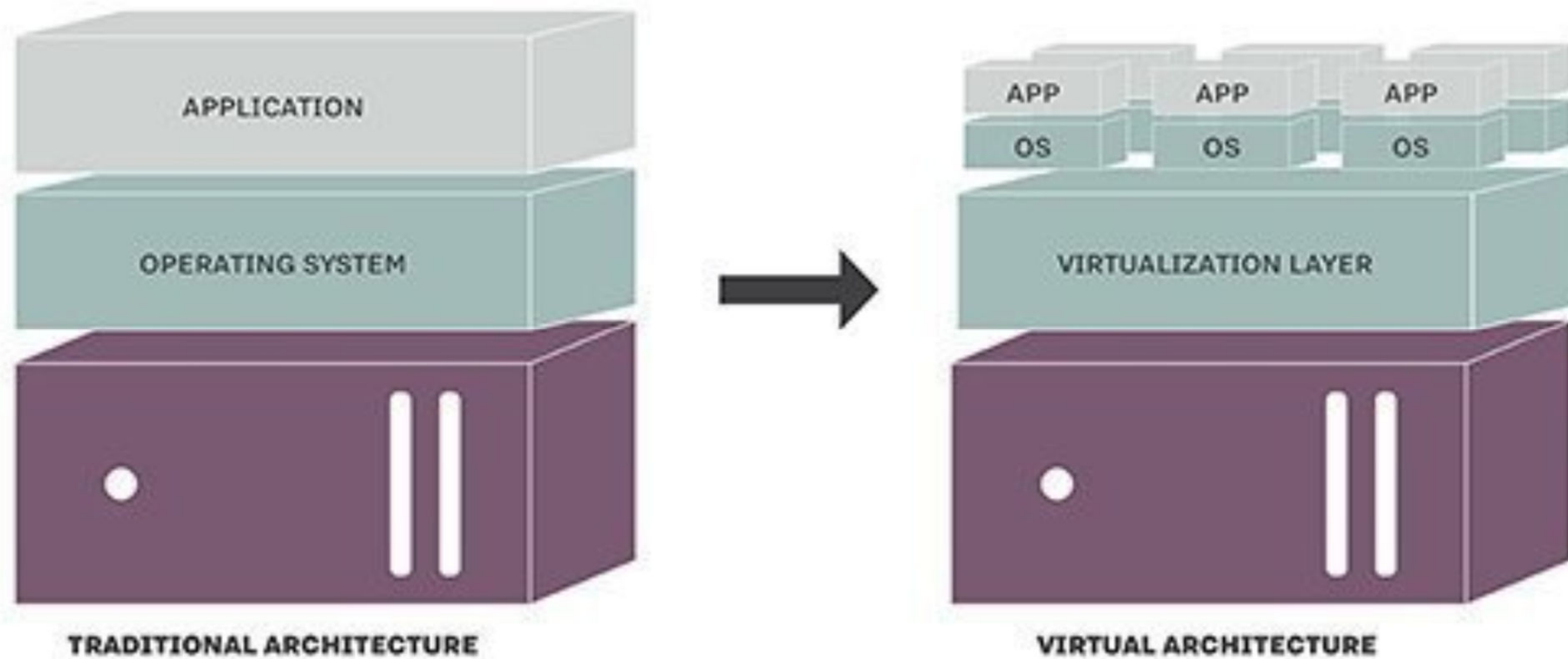
- Hardware is underutilized
- Data center run out of space
- Energy cost go through the roof
- System administration costs mount



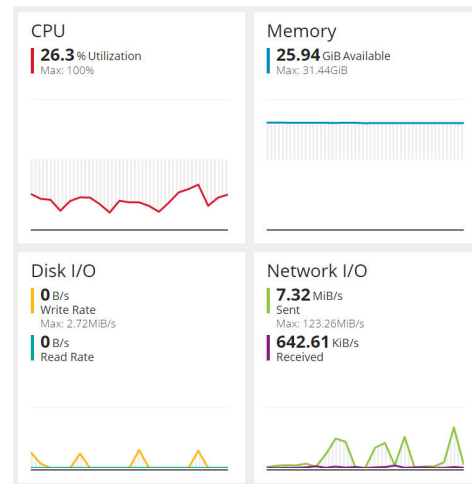
Type of virtualization

- Based on the level at which virtualization occurs and the resources being virtualized
 - Hardware virtualization (server virtualization), Ex. Vmware, Hyper-V, Virtualbox
 - OS virtualization (Container), Ex. Docker, Kubernetes, LXC (Linux containers)
 - Network virtualization, Ex. Vmware NSX, Cisco ACI
 - Storage virtualization, Ex. SAN, NAS
 - Desktop virtualization, Ex. VDI technology, Citrix Virtual Desktops, Vmware Horizon.
 - Application virtualization, Ex. Microsoft App-V, Vmware ThinAPP

Server/hardware/X86 virtualization

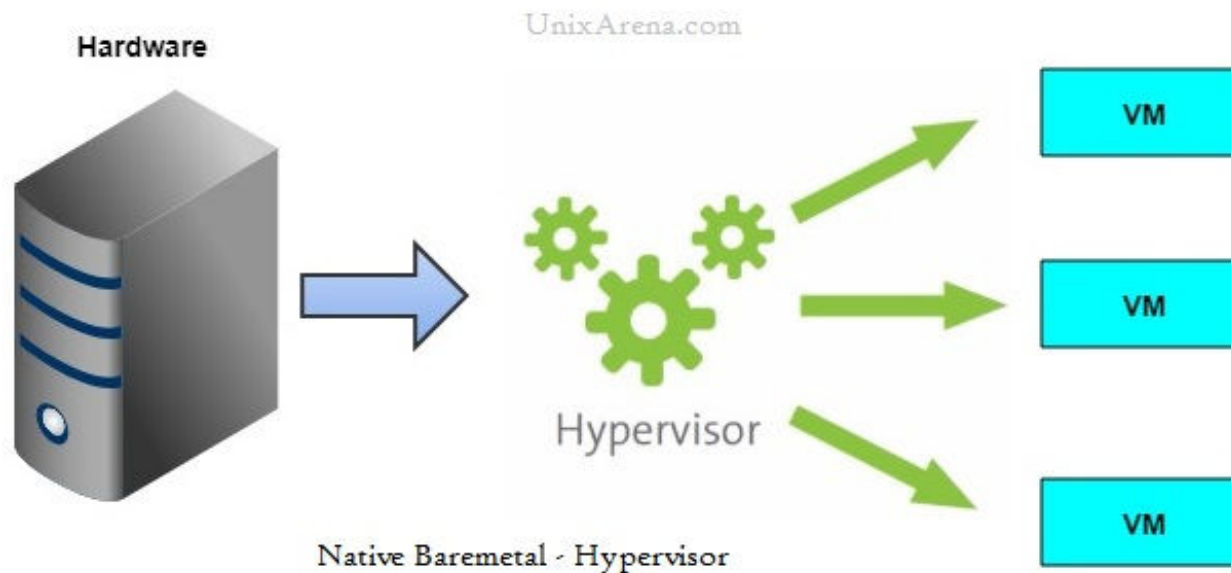


TYPE of hypervisor



Guest Name ID	OS Type	Processors Utiliz...	Memory Utilizati...	Storage I/O	Network I/O	Actions
ansible	Ubuntu	1%	3%	0KB/s	0KB/s	Actions
go-dev	Ubuntu	0%	68%	0KB/s	0KB/s	Actions
greenpithumb-d...	Ubuntu	0%	59%	0KB/s	0KB/s	Actions
jeekyll	Ubuntu	0%	3%	0KB/s	0KB/s	Actions
python	Ubuntu	0%	45%	0KB/s	0KB/s	Actions
ubuntu16.04.149...	Ubuntu	--	--	--	--	Actions
ubuntu16.04.149...	Ubuntu	--	--	--	--	Actions

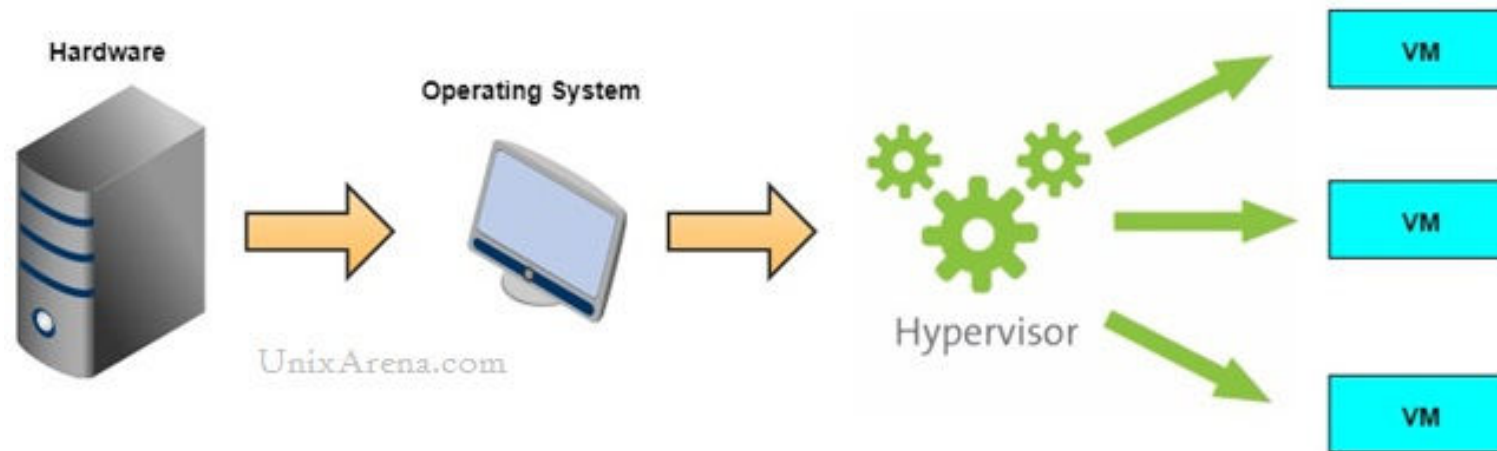
- Bare-Metal Hypervisor (TYPE I)
- Hosted based Hypervisor (TYPE II)



- Vmware ESXi / ESX
- KVM
- Hyper-V
- XEN
- Proxmox

Native bare-metal (Type I hypervisor)

Introduction to Hypervisor and Mastering Virtualbox by Tuul
Triyason, Ph.D.



Hosted - Hypervisor - Type 2

- Vmware Workstation (64bit guest only)
- VirtualBox (64bit guest only)
- Vmware Server (retired)

hosted (Type II hypervisor)

Introduction to Hypervisor and Mastering Virtualbox by Tuul
Triyason, Ph.D.

Characteristics of a Hypervisor

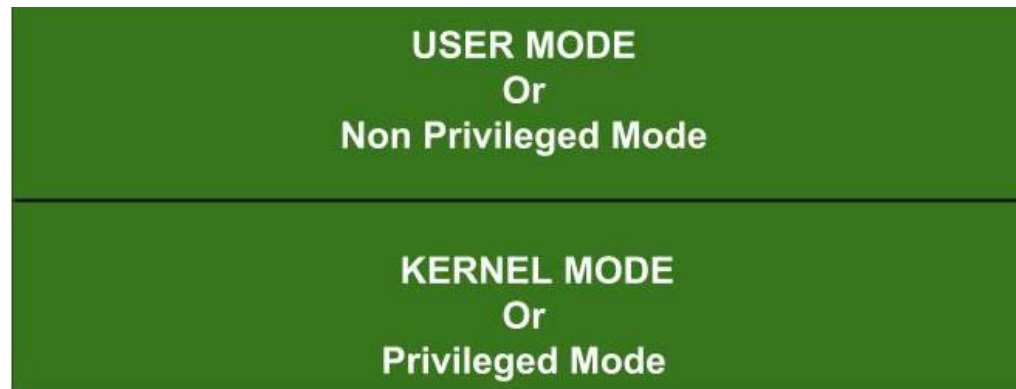
- Isolation
- Resource Management
- Hardware Abstraction
- Encapsulation



Virtualization approaches to virtualizing resources

- **Full Virtualization:** The virtual machine simulates the complete hardware, allowing an unmodified guest operating system to run in isolation.
 - Hardware-Assisted (VT): CPU provides special extensions that are design to support virtualization more efficiently such as Intel VT-x, AMD-V
 - Software-Assisted (BT): also known as “binary translation”, the hypervisor uses software techniques to intercept and translate privileged instructions executed by the guest OS into a form that can be safely executed on the host CPU.
- **Paravirtualization:** The guest OS is modified to be aware that it is running in a virtualized environment. This allows for more efficient communication between the guest OS and the hypervisor. An example of a hypervisor that supports paravirtualization is Xen, which can run modified guest OS with paravirtualized drivers.
- **Hybrid Virtualization:** It combines elements of both full virtualization and paravirtualization. (Hypervisor provides a fully virtualized environment for the guest OS, but certain components such as device drives, are paravirtualized to improve performance.

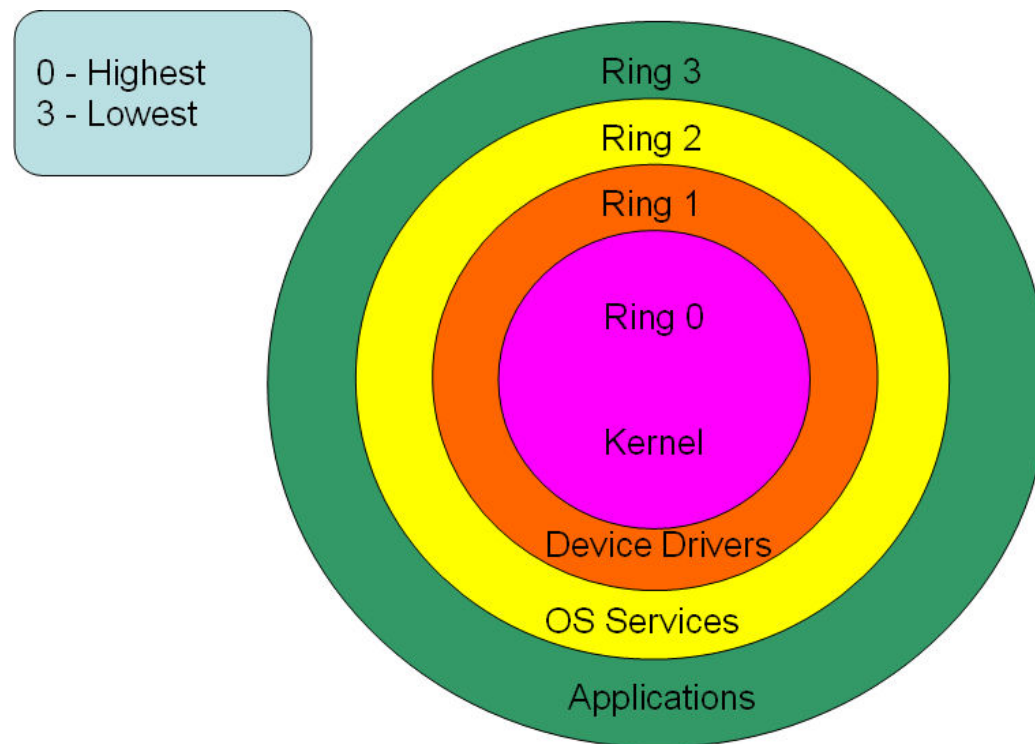
Privileged and non-Privileged instruction in OS



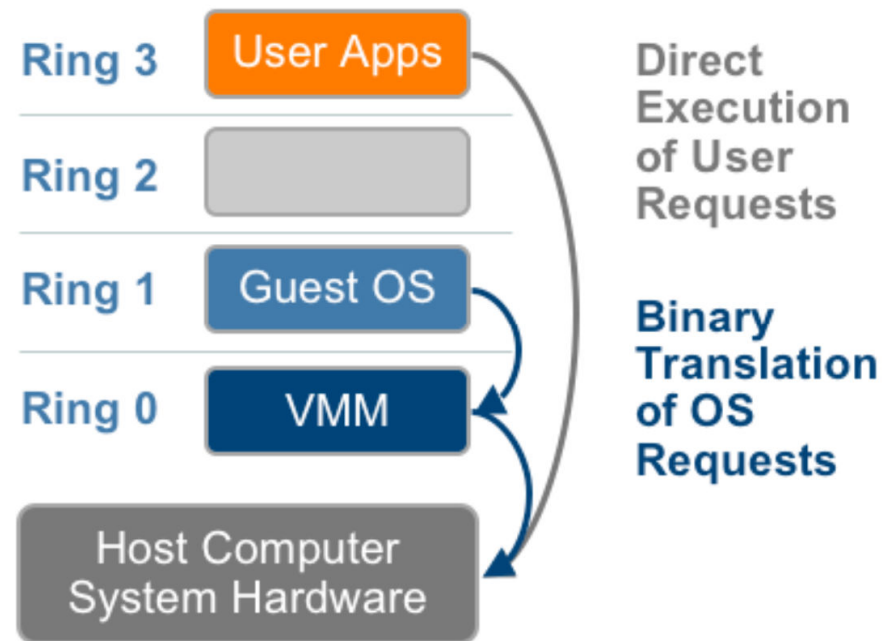
Privileged instruction

- I/O instruction and halt instruction
- Turn off all interrupts
- Set the timer
- Context Switching
- Clear memory or remove processes from memory

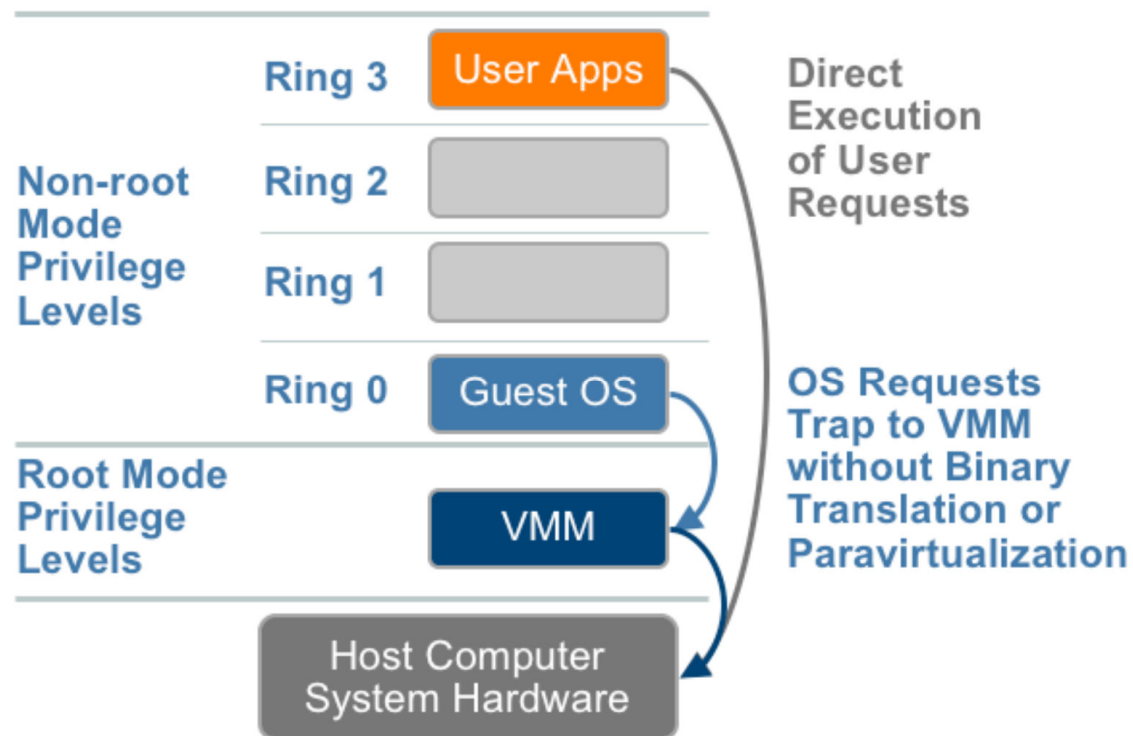
X86 protection rings



Software assisted - Full virtualization (BT – Binary translation)

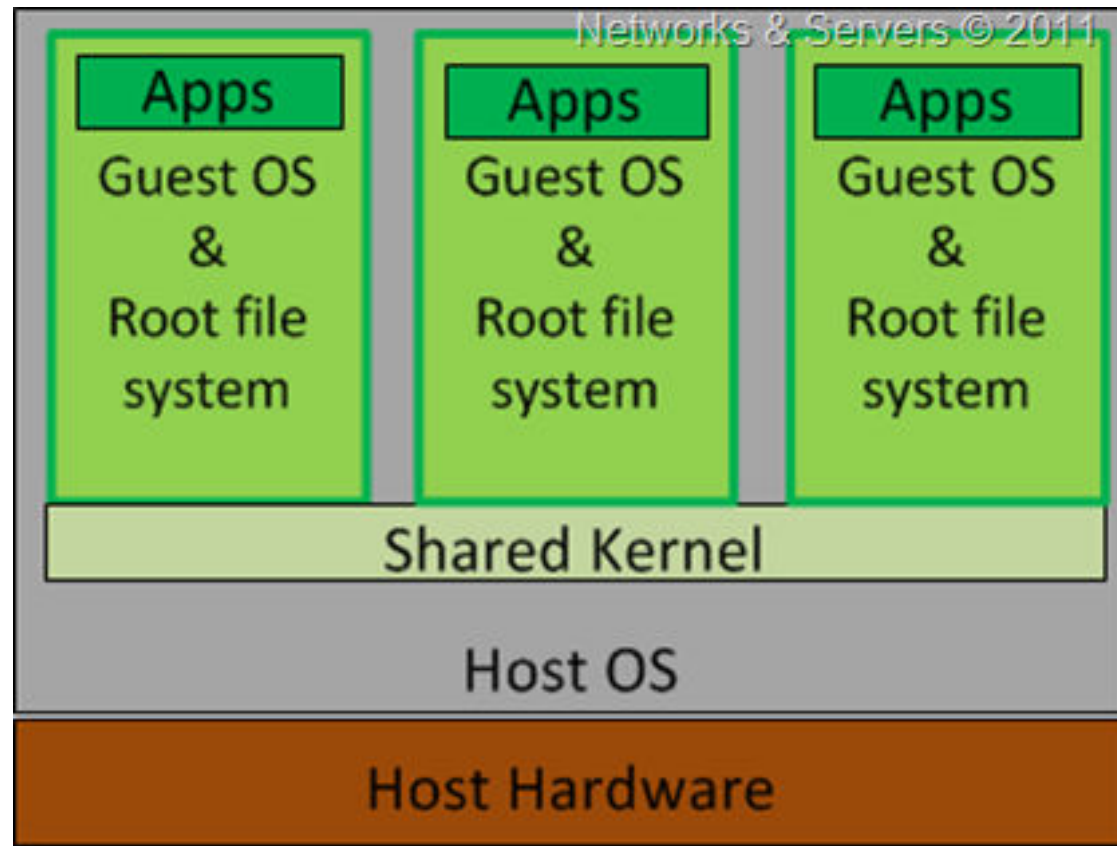


hardware assisted - Full virtualization (VT)



OS Level Virtualization

- Also knowns “Containerization”.
- There will be very little or no overhead since it used the host operating system kernel for execution.



Oracle Virtualbox

- **Type:** Hybrid virtualization software that uses full virtualization for general operation and paravirtualization for specific components to enhance performance.
- **Functionality:** Allows users to create, manage, and run multiple VM with different OS on a single physical computer, providing an isolated and sandboxed environment for each VM.
- **Use cases:** Ideal for development, testing, and educational purposes, enabling users to experiment with different OS, configurations and software without affecting the host system.



Timeline of Virtualbox

- **2007:** VirtualBox was initially developed by Innotek GmbH and released as a free and open-source software. It quickly gained popularity for its simplicity and cross-platform support.
- **2008:** Sun Microsystems acquired Innotek GmbH, and VirtualBox became part of the Sun xVM virtualization platform. During this time, VirtualBox continued to evolve, adding new features and support for additional guest operating systems.
- **2010:** Oracle Corporation acquired Sun Microsystems, and VirtualBox became part of Oracle's product portfolio. Oracle continued to develop and support VirtualBox, releasing new versions with enhanced capabilities.
- **2010-2023:** Over the years, Oracle VirtualBox has seen numerous updates and improvements, including enhanced performance, support for newer operating systems, and advanced features like virtual machine cloning, snapshots, and better integration with different host operating systems.
- **2024:** As of 2024, VirtualBox remains a popular choice for virtualization, widely used in development, testing, and educational environments for its ease of use, cross-platform compatibility, and robust feature set.

Why did I choose to teach VirtualBox instead of VMware?



- The primary reason is that **IT IS FREE!!!**, and the university no longer provides VMware licenses (*they used to in the past, but the economy is not good, and the university is becoming poorer, lacking income from students*).
- Personally, I have a VMware license, but I barely use it because when it comes to teaching, most students don't have enough money to purchase VMware. Therefore, most students end up using VirtualBox.
- From my experience using both software, I can say that VMware has better performance and is easier to use. But that's the thing, VirtualBox is free, and making it work well also **proves your skills** in customization.