

# Virtualization

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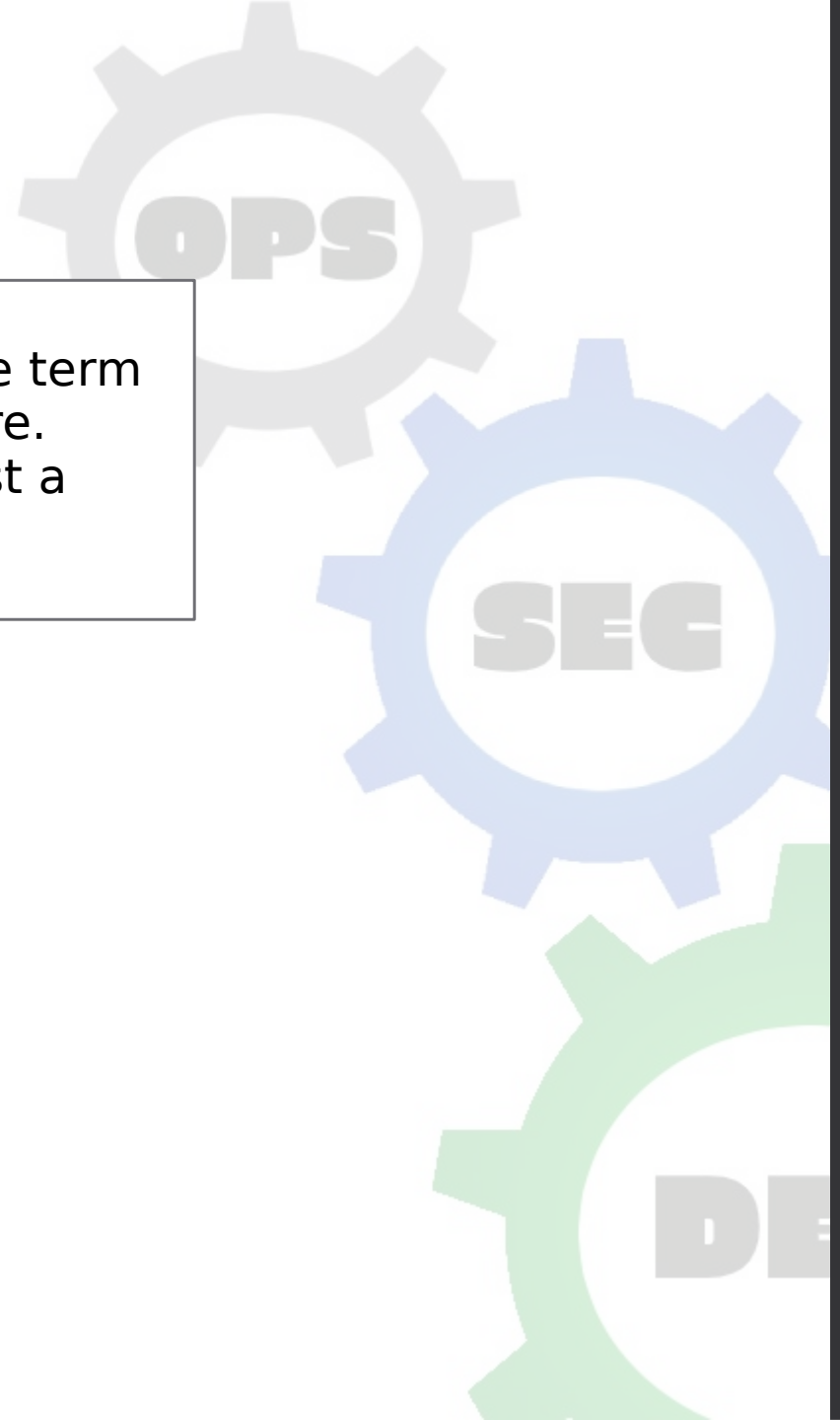
**Virtualization** is a term that refers to various techniques, methods or approaches of creating a virtual version of something.



# Virtualization Types

- ◆ Hardware Virtualization
- ◆ Container Virtualization
- ◆ Application Virtualization
- ◆ Presentation Virtualization
- ◆ More...

Nowadays you can see the term **Virtualization** everywhere. Most of the time this is just a marketing trick!



# Hardware Virtualization

Virtual Machines

# Hardware Virtualization

- ◆ Virtual Machine (VM) acts like a real computer
  - ◆ operating system
  - ◆ applications
- ◆ Hypervisor
  - ◆ The software that creates and manages the virtual machines
- ◆ We also use the terms
  - ◆ Guest OS
  - ◆ Host OS



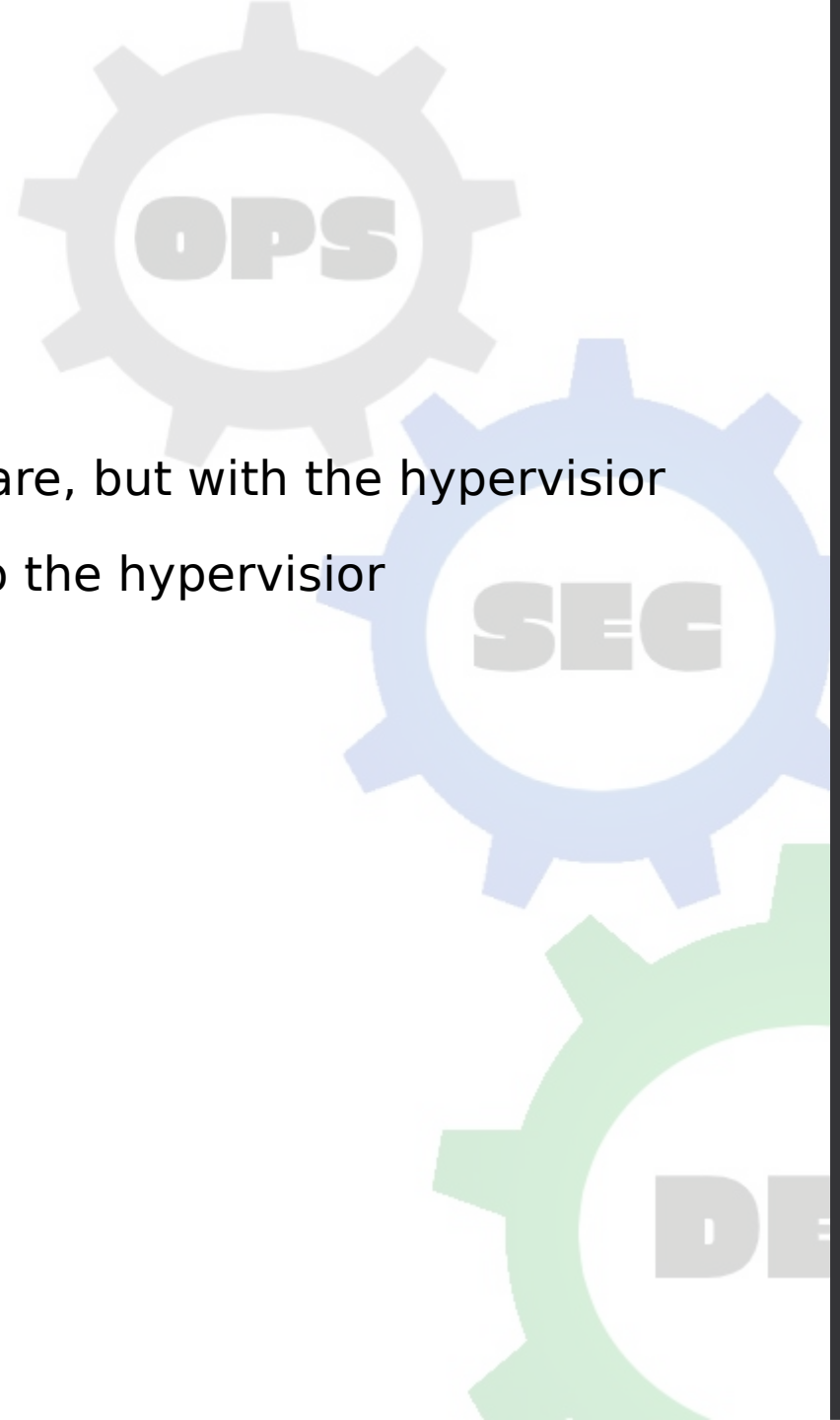
# Full Virtualization

- ◆ Guest OS is not aware it is virtualized
- ◆ Guest OS requires no modification
- ◆ Virtual Machine has all standard components
  - ◆ Virtual processors
  - ◆ Memory
  - ◆ Network Adapters
  - ◆ Virtual Disks



# Para virtualization

- ◆ Guest OS is modified
- ◆ Guest OS is aware that it is running on a hypervisor
- ◆ Guest OS does not communicate directly with the hardware, but with the hypervisor
- ◆ All privileged instructions are replaced with direct calls to the hypervisor



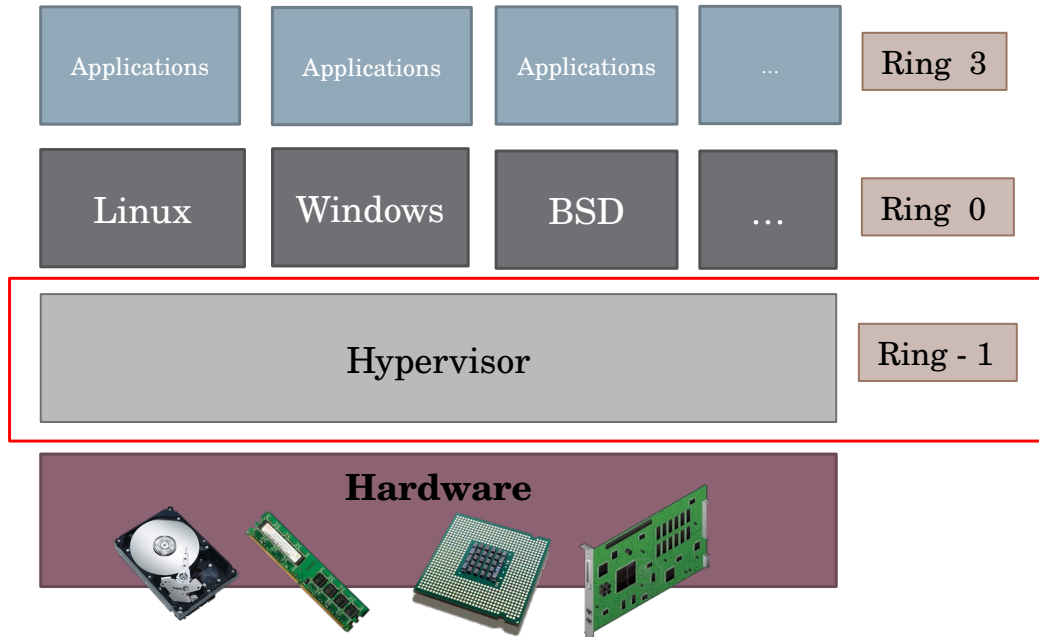
# What we use today?

Full or Para Virtualization



# Hardware assisted virtualization

- ◆ Approach that enables efficient **full virtualization** using help from hardware capabilities



# Hardware assisted virtualization G1

- ◆ The modern CPU's include hardware assisted virtualization
  - ◆ Intel-VT
  - ◆ AMD-V
- ◆ Introduced first in 2005 (Intel-VT)
- ◆ Makes it possible to support unmodified guests
  - ◆ No emulation
  - ◆ No instructions translation



# Hardware assisted virtualization G2

- ◆ Second Level Address Translation (SLAT)
  - ◆ Intel VT Extended Page Tables (NPT)
  - ◆ AMD-V Rapid Virtualization Indexing (RVI)



# Hardware assisted virtualization G3

- ◆ Nested Virtualization?
- ◆ PCI Express Virtualization?
  - ◆ Makes one device “look” like multiple devices
  - ◆ Virtual devices appear completely independent



# So what we use today?

- ◆ Hardware assisted virtualization!
- ◆ But wait! That's not all.
  - ◆ We also use para-virtualized devices
  - ◆ Para-virtualized devices are optimized virtual devices designed for Virtualization
    - Decrease I/O latency
    - Increase I/O throughput
    - Provide near bare-metal performance
    - Needs special device drivers
- ◆ Conclusion – The Virtualization today
  - ◆ We use combination of full and para virtualization
  - ◆ OS is not modified since we use the effective hardware assisted virtualization
    - CPU and Isolation rings
    - Memory Management
  - ◆ We use special para-virtualized devices and drivers to provide effective I/O performance
    - Storage
    - Networking
    - Etc.



# Example of Hypervisors

- ◆ VMWare ESXi
- ◆ Hyper-V
- ◆ KVM
- ◆ XEN
- ◆ VirtualBox

