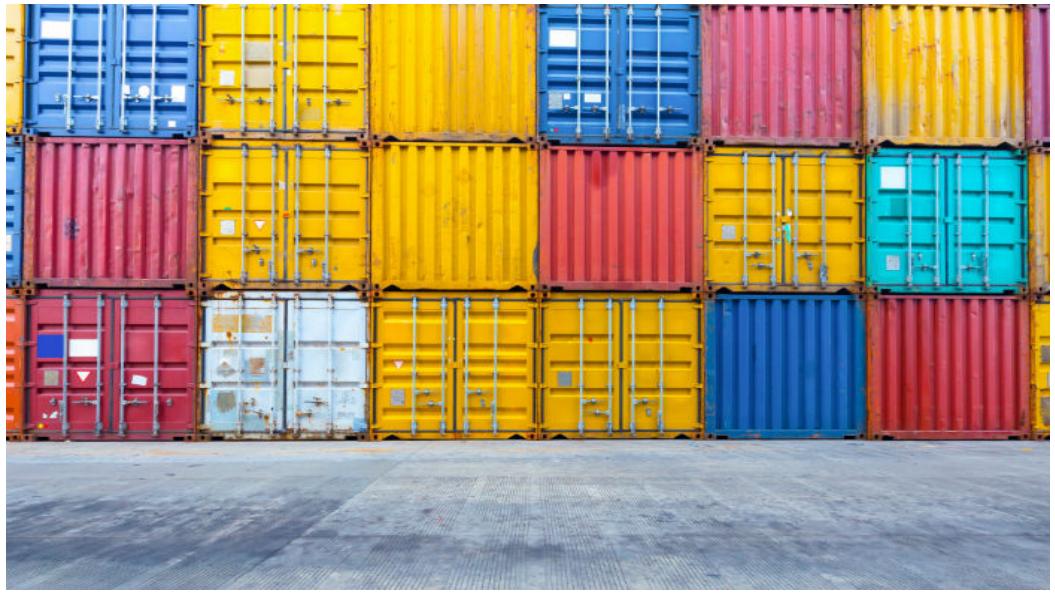
Virtualization and Containerization

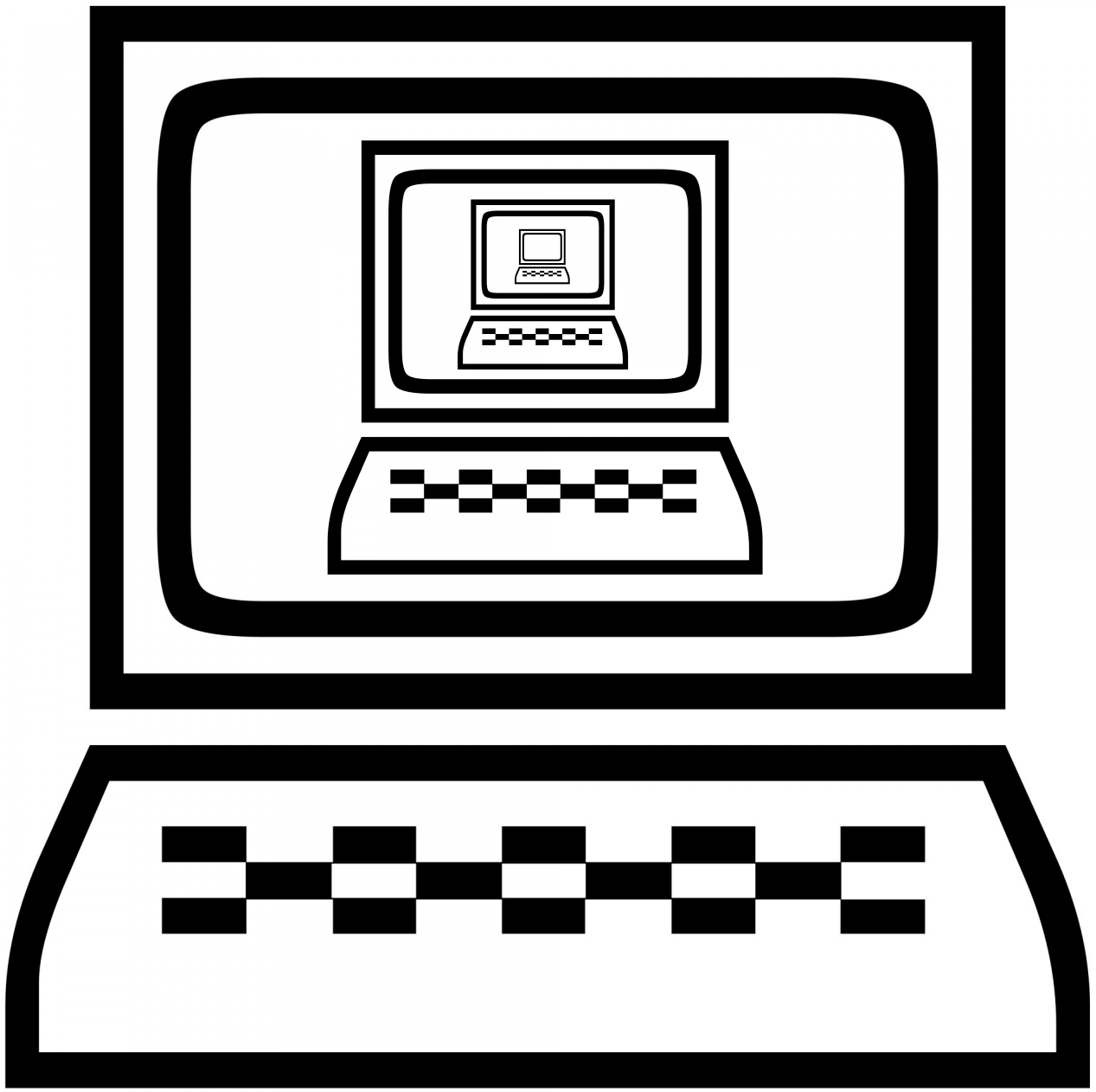


At a **high level**, how do computers work?

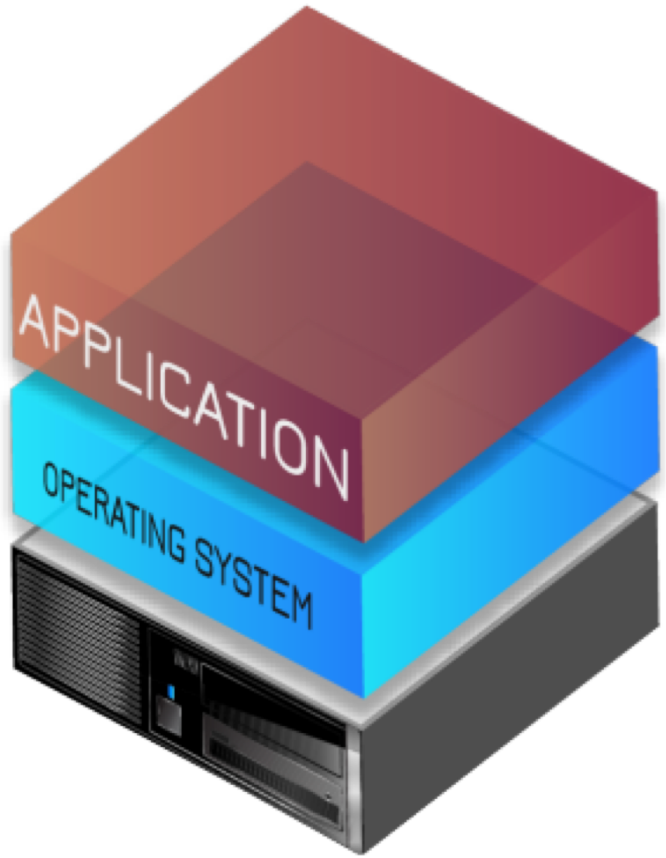
Traditional Computers

Linux

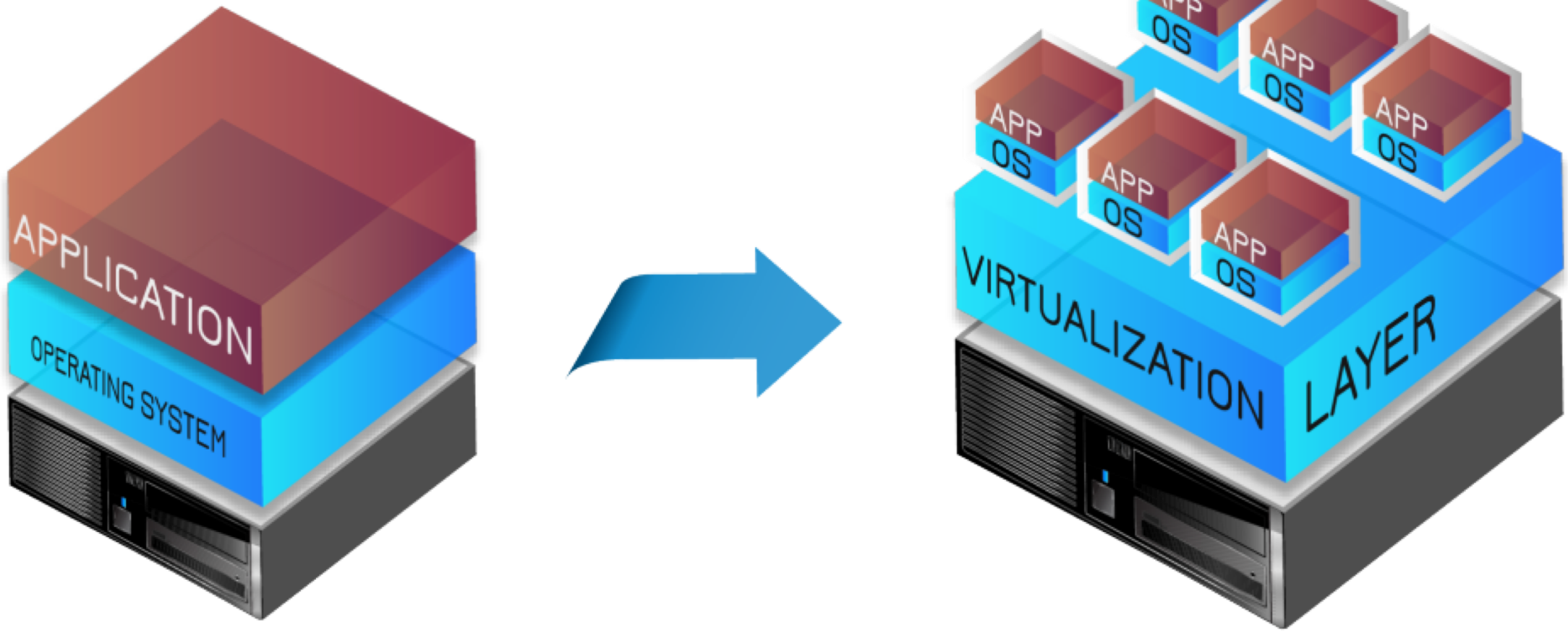
Take a guess at what Virtualization and Containerization are…



Virtualization

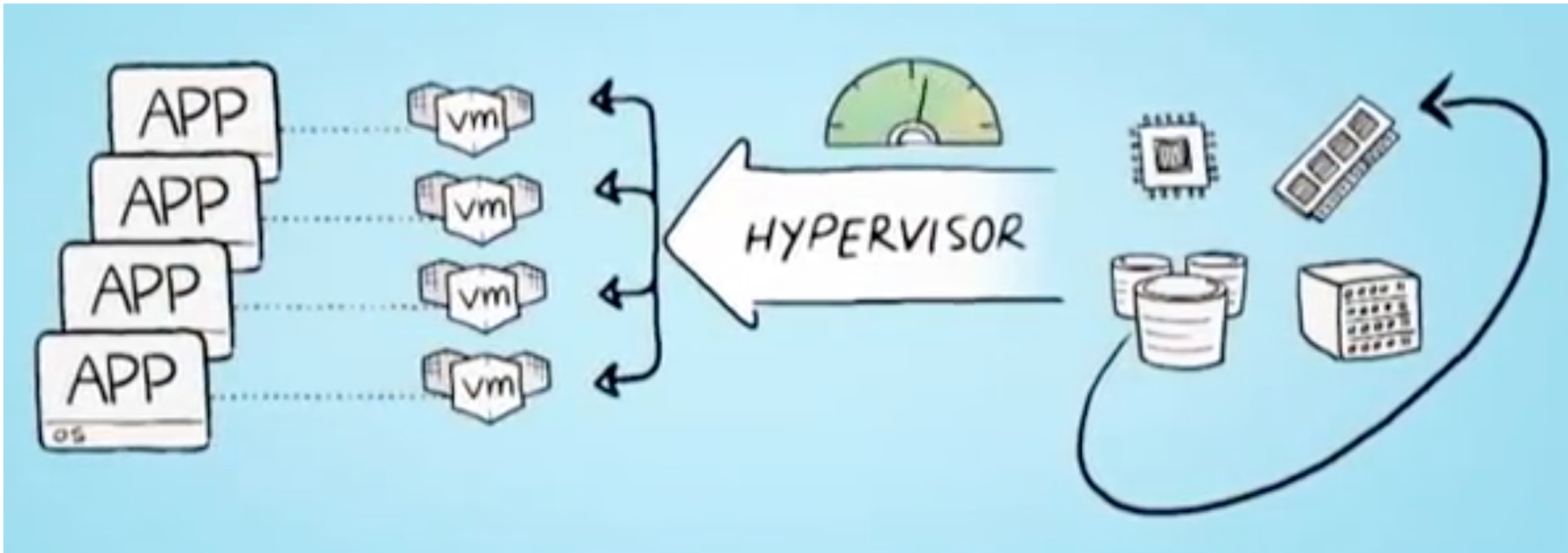


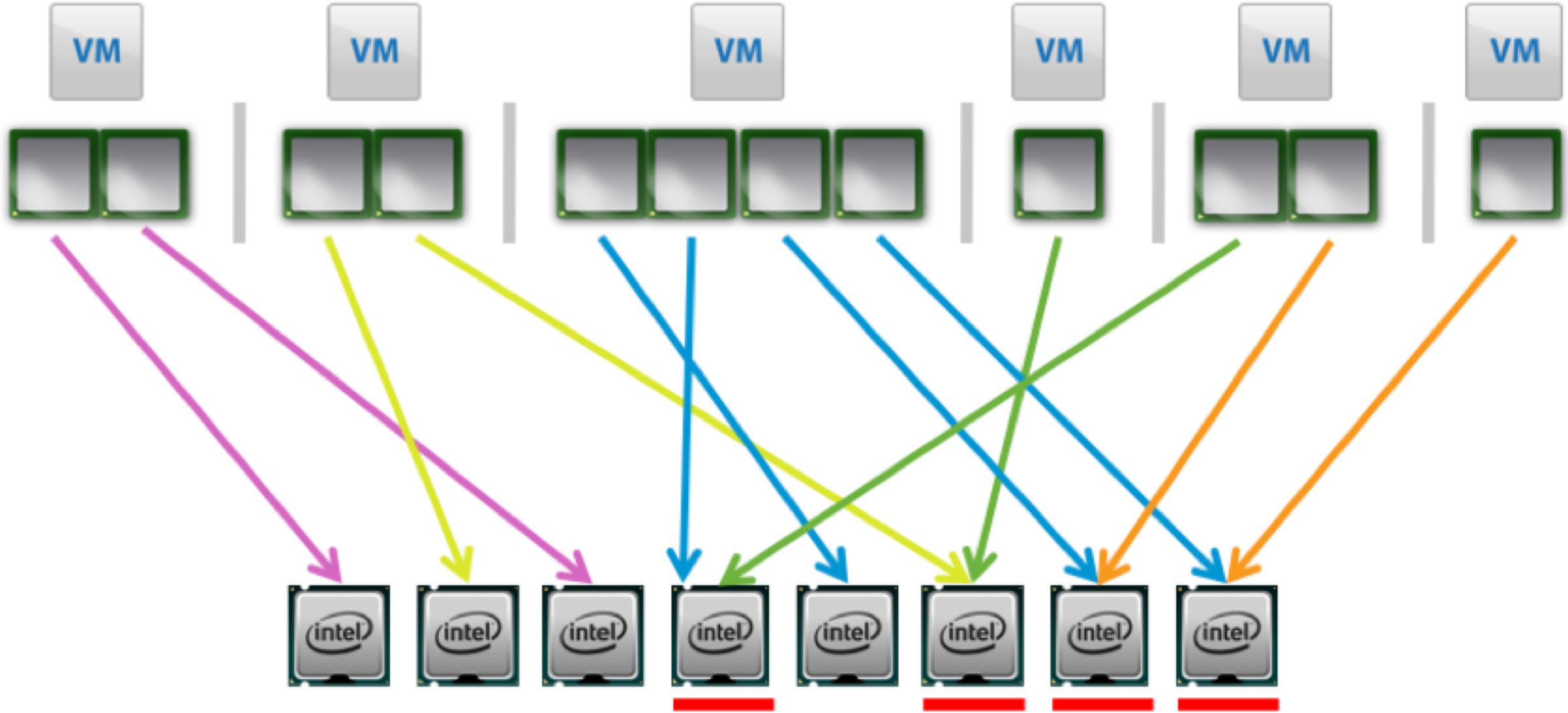
Traditional Architecture



Traditional Architecture

Virtual Architecture


APP
APP
APP
APP
OS
vm
vm
vm
vm
HYPERVISOR


VM
VM
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intel
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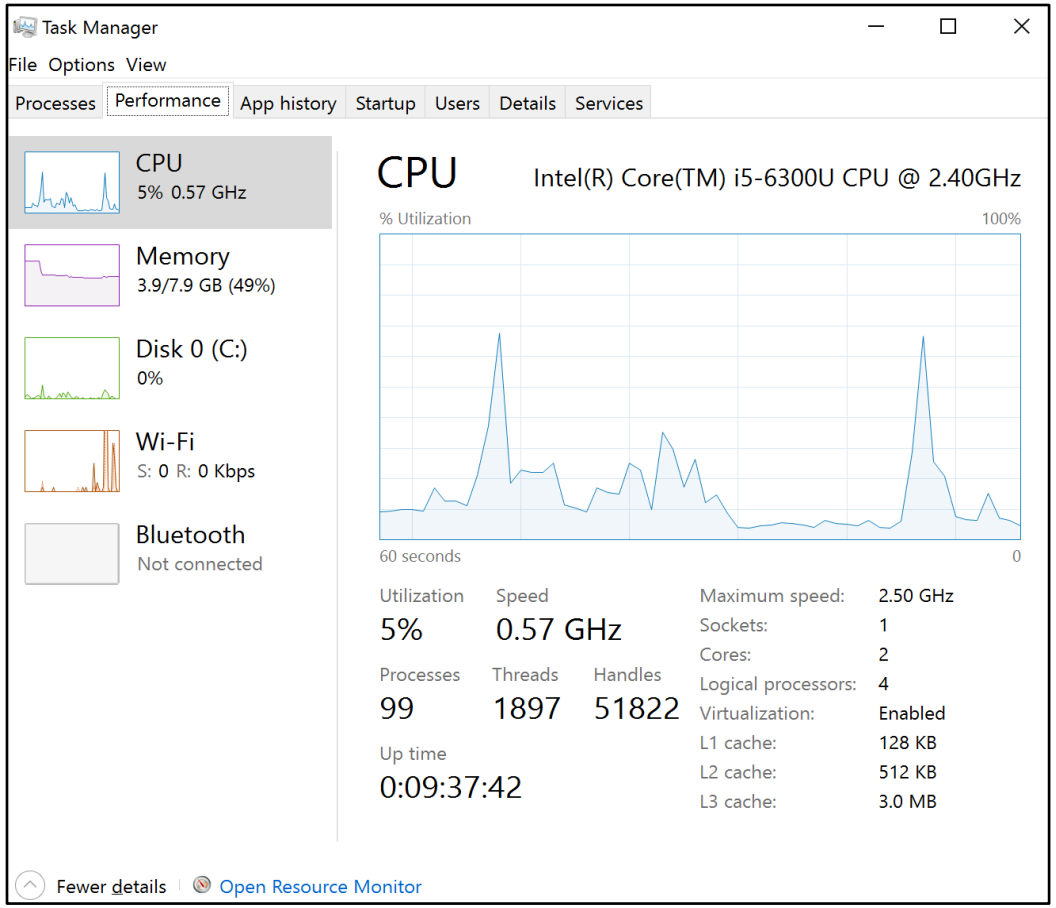
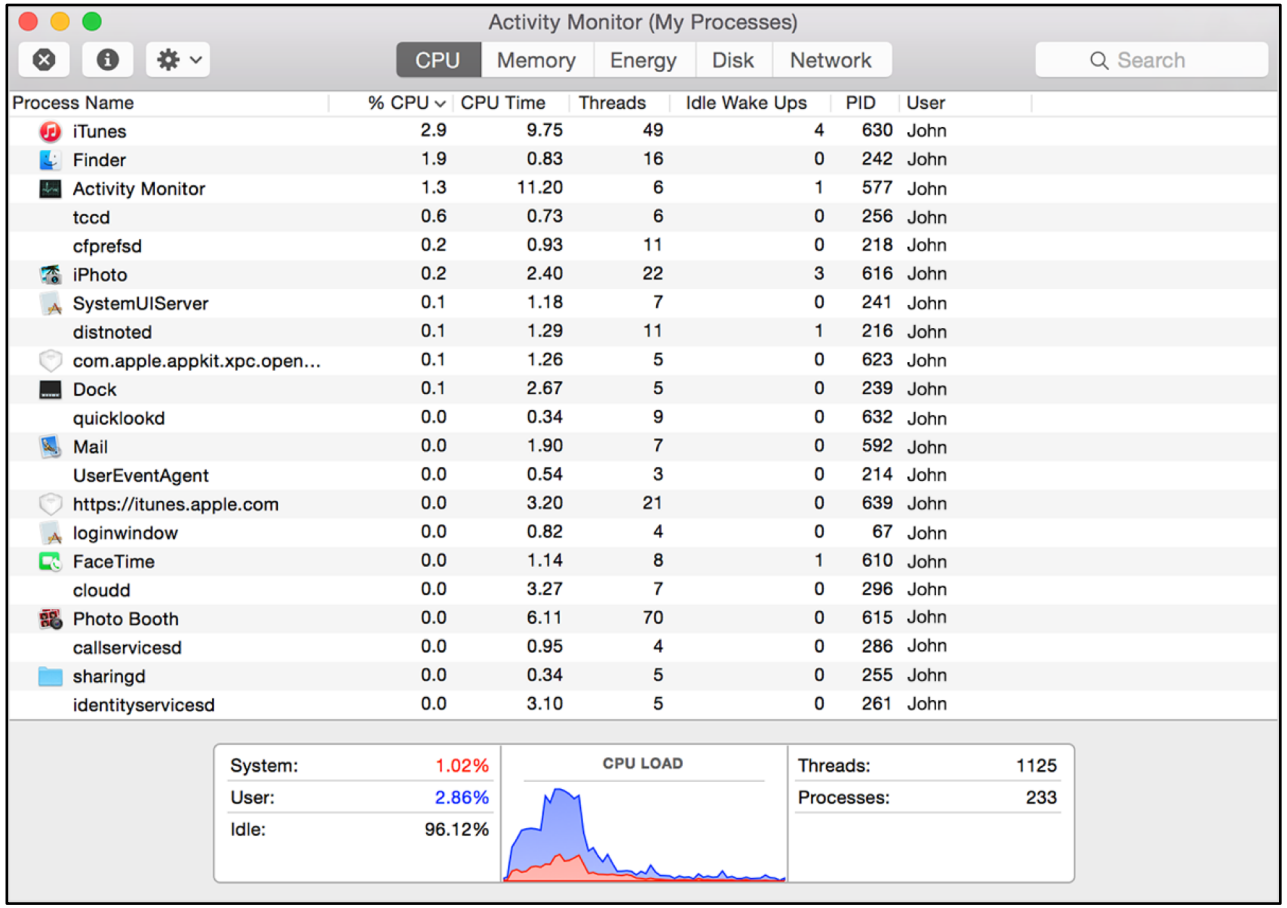
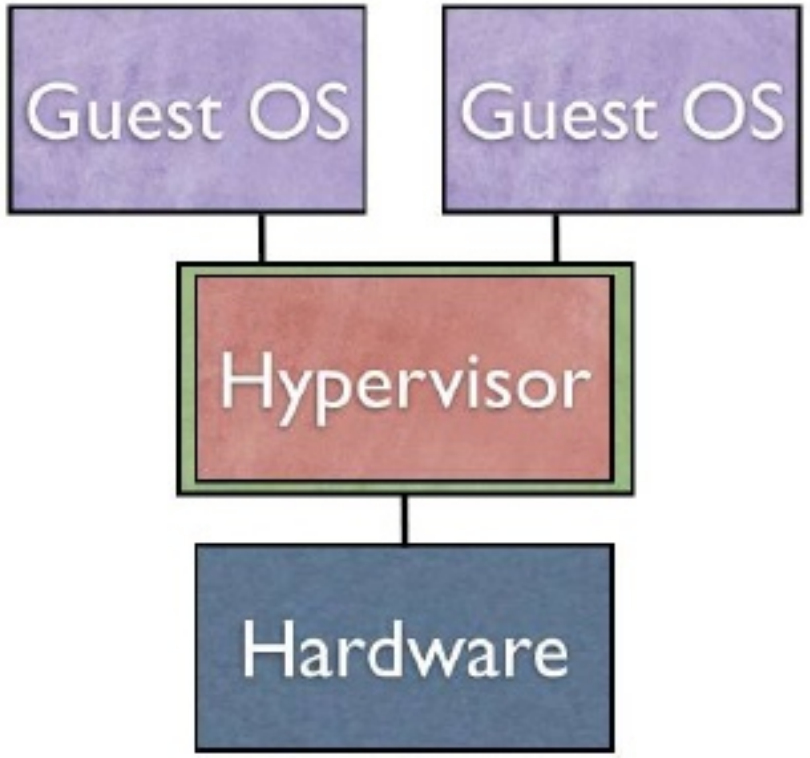
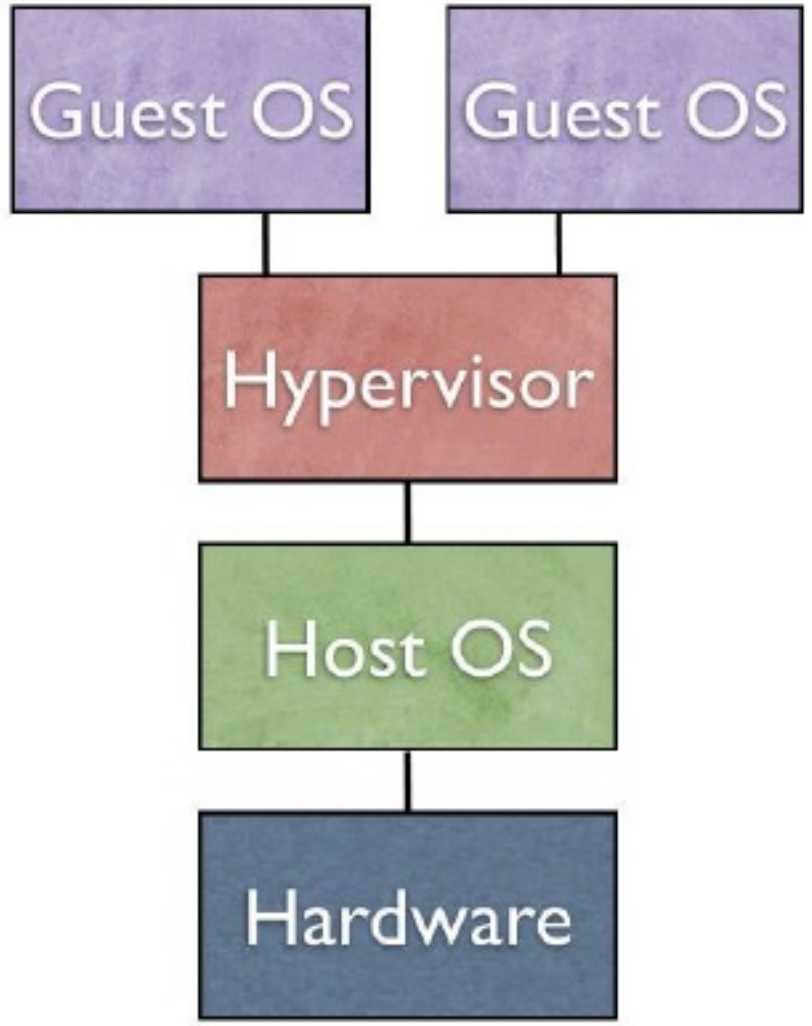

Task Manager
File Options View
Processes Performance App history Startup Users Details Services
CPU
5% 0.57 GHz
Memory
3.9/7.9 GB (49%)
Disk 0 (C:)
0%
Wi-Fi
S: 0 R: 0 Kbps
Bluetooth
Not connected
CPU
Intel(R) Core(TM) i5-6300U CPU @ 2.40GHz
% Utilization
100%
60 seconds
0
Utilization
5%
Speed
0.57 GHz
Processes
99
Threads
1897
Handles
51822
Up time
0:09:37:42
Maximum speed: 2.50 GHz
Sockets: 1
Cores: 2
Logical processors: 4
Virtualization: Enabled
L1 cache: 128 KB
L2 cache: 512 KB
L3 cache: 3.0 MB
Fewer details
Open Resource Monitor


Activity Monitor (My Processes)
CPU Memory Energy Disk Network
Search
Process Name % CPU CPU Time Threads Idle Wake Ups PID User
iTunes 2.9 9.75 49 4 630 John
Finder 1.9 0.83 16 0 242 John
Activity Monitor 1.3 11.20 6 1 577 John
tccd 0.6 0.73 6 0 256 John
cfprefsd 0.2 0.93 11 0 218 John
iPhoto 0.2 2.40 22 3 616 John
SystemUIServer 0.1 1.18 7 0 241 John
distnoted 0.1 1.29 11 1 216 John
com.apple.appkit.xpc.open... 0.1 1.26 5 0 623 John
Dock 0.1 2.67 5 0 239 John
quicklookd 0.0 0.34 9 0 632 John
Mail 0.0 1.90 7 0 592 John
UserEventAgent 0.0 0.54 3 0 214 John
https://itunes.apple.com 0.0 3.20 21 0 639 John
loginwindow 0.0 0.82 4 0 67 John
FaceTime 0.0 1.14 8 1 610 John
cloudd 0.0 3.27 7 0 296 John
Photo Booth 0.0 6.11 70 0 615 John
callservicesd 0.0 0.95 4 0 286 John
sharingd 0.0 0.34 5 0 255 John
identityservicesd 0.0 3.10 5 0 261 John
System: 1.02%
User: 2.86%
Idle: 96.12%
CPU LOAD
Threads: 1125
Processes: 233



Type 1 (Hardware Level)



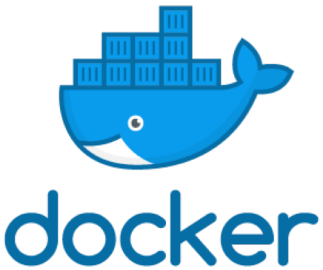
Type 2 (OS Level)

Characteristics of Virtual Machines

- **Partitioning**
  - Run multiple operating systems on one physical machine.
  - Divide system resources between virtual machines.
- **Isolation**
  - Provide fault and security isolation at the hardware level.
  - Preserve performance with advanced resource controls.
- **Encapsulation**
  - Save the entire state of a virtual machine to files.
  - Move and copy virtual machines as easily as moving and copying files.
- **Hardware Independence**
  - Provision or migrate any virtual machine to any physical server.

Benefits of Virtualization

- Higher performance at a lower cost due to resource optimization
- Better security as you can prevent operating systems from communicating to one another
- Reduced capital and operating costs
- Faster provisioning of applications and resources

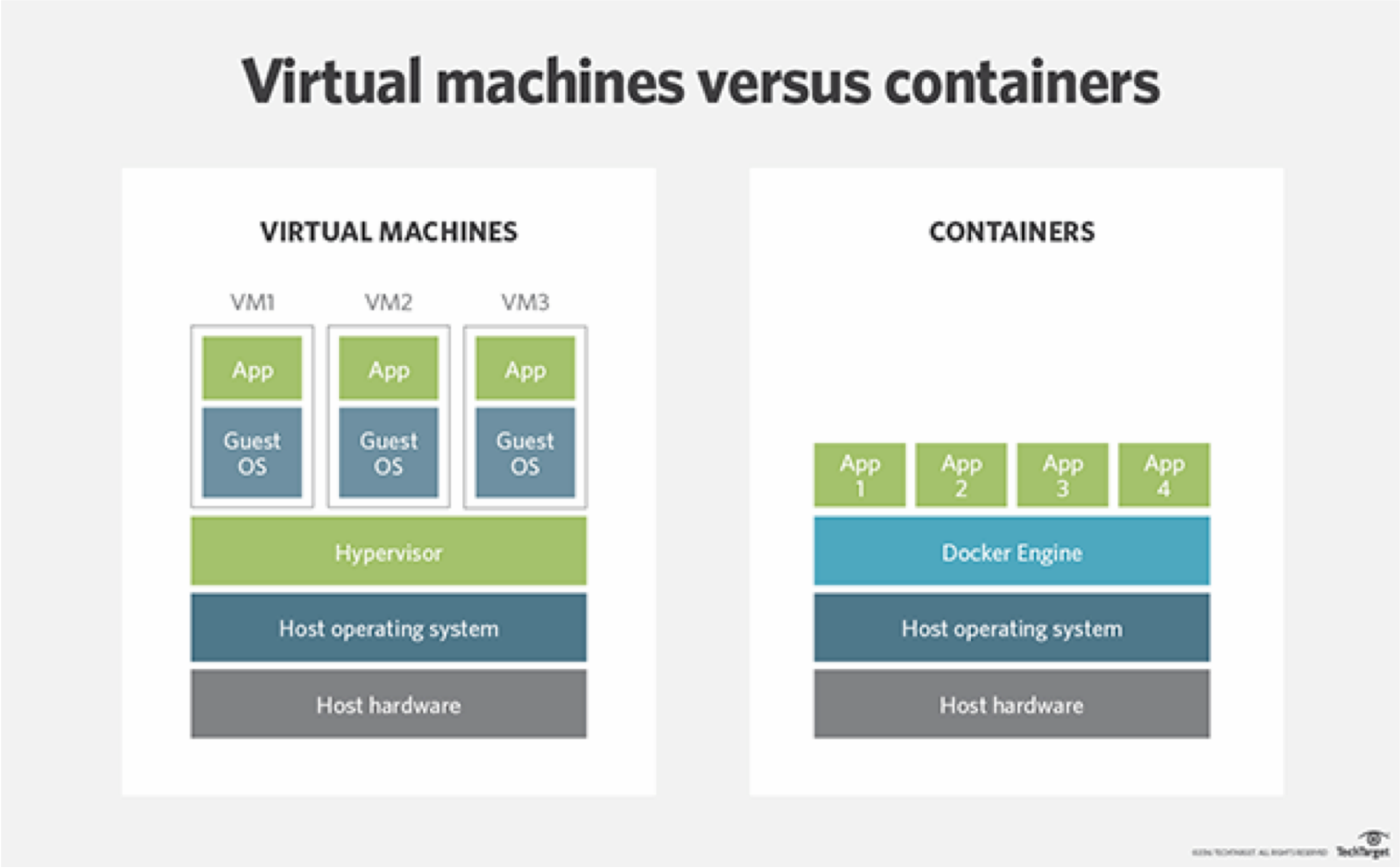


Containers!

What are Containers?

- Lightweight, portable software packages
  - Only contain the software, libraries, and other dependencies they require to run so you can put them directly on the host operating system.
- Smaller version of Virtual Machines, only have the bare necessities
  - 20 MB vs 20 GB
- Operating system kernel via API calls with other containers on a host
- Many Variations
  - Most Popular = Docker

Containers vs. Virtual Machines



Why Use Containers?

- Performance
  - Without any hypervisor, much more stable without the need of more resources
- Reliability
  - Predictable apps created within containers
  - Distribution ensures anything downloaded works the exact same within container
- App Isolation
  - Developers get exactly what they need, no more no less, only dependencies needed are downloaded
    - Can alter changes within the container but not on the host OS
  - Allows for greater security - Split resources by container
- Availability
  - Can be downloaded anywhere, anytime and on ANY operating system – Very Portable
    - Will work the same way across platforms (Mac, Linux, Windows)

Issues with Containerization

- No isolation from host OS (Docker)
  - Root access required
  - Once inside container, have root access
- Container Malware
  - Can be distributed much more easily with containers
- Denial of Service Attacks
  - Multiple containers share same Kernel resources
  - If you can grab kernel resources, can starve all containers on system

What's the Difference??

	Containers	Virtual Machines
Consistent Runtime Environment	X	X
Application Sandboxing	X	X
Resource Allocation	X	X
Small Size on Disk	X	
Low Overhead	X	

Can I use a virtual machine?

Server: cdr-vcenter1.cse.buffalo.edu

Username: ad\UBIT

Password: UBIT Password