



14-848 Cloud Infrastructure

LECTURE 2

VIRTUALIZATION

Agenda


- Why Virtualization is Important?
- What is Virtualization?
- Traditional Server Infrastructure
- Virtual Server Infrastructure
- Hypervisors
- Create Virtual Machines on Your Local Machine
- Virtual Machines on the Cloud
- Next Steps – Install Docker



Why to study Virtualization?

Cloud Infrastructure = Data Center + Virtualization

- In this lecture, we will look at Virtualization at a high-level



Virtualization is an abstraction layer over the hardware you have.
The software layer (VMs, operating systems, applications) is no longer tied to specific physical hardware.
You don't need to know whether the underlying server is HP, Dell, or IBM — virtualization hides those details for you.

What is Virtualization? 虛擬化

- Virtualization abstracts the hardware of computing infrastructure into several different execution environments.
 - It creates the illusion that each separate environment is running on its own private computing infrastructure
 - It makes servers, workstations, storage, network and other systems independent of the physical hardware layer
- Virtualization is the fundamental technology that powers Cloud Infrastructure! Virtualization: independent execution environments, leveraging the hardware capacity
 - Virtual resources can be started and stopped easily and quickly.

Virtualization - Definitions

Virtualization

- The process of creating a ^{abstract} virtual version of a physical object.

Virtual Machine

- Visual representation of a physical machine (Not JVM).

Virtual Machine Monitor (VMM) or Hypervisor ^{VMM is the software that allows you to create VM}

- A process that separates a computer's operating system and applications from the underlying physical hardware.
- Hypervisor monitors and manages running virtual machines.

Host Machine

- The physical machine that a virtual machine is running on.

Guest Machine

- The virtual machine, running on the host machine.

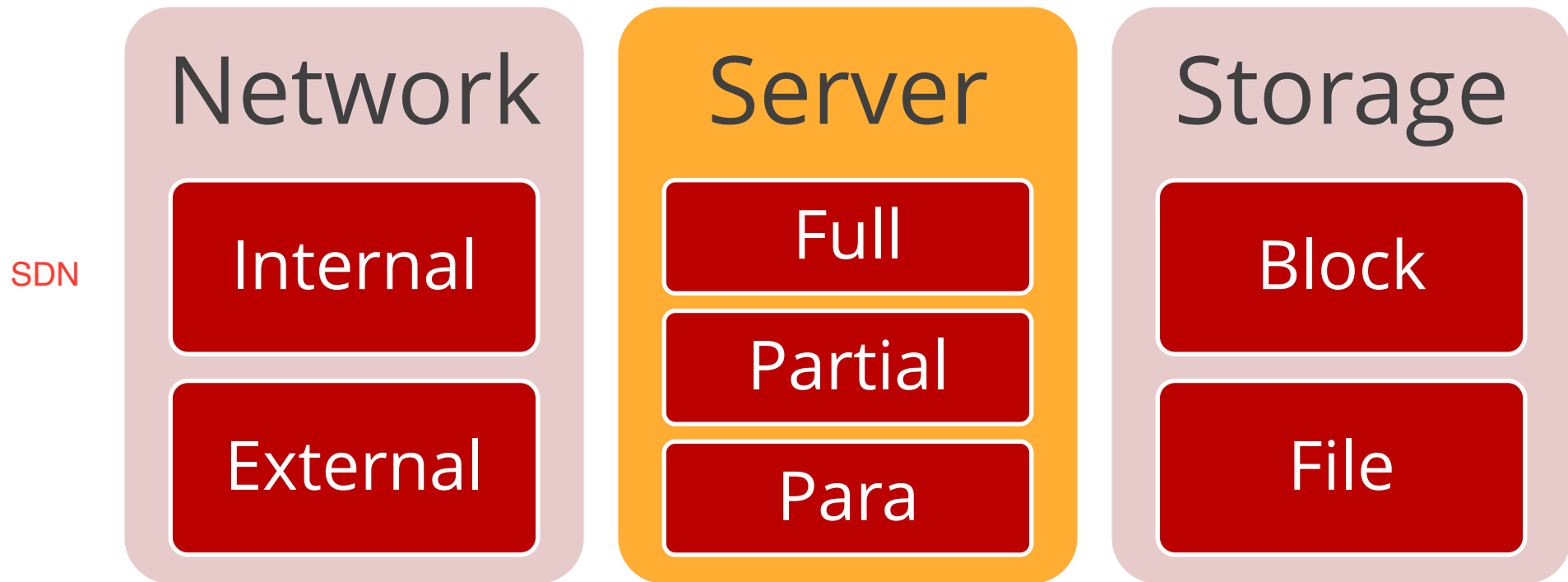


Why Virtualization is Important?

The following video answers this question:

https://www.youtube.com/watch?v=vUUC_eDb2z0

Most Important Virtualization Types



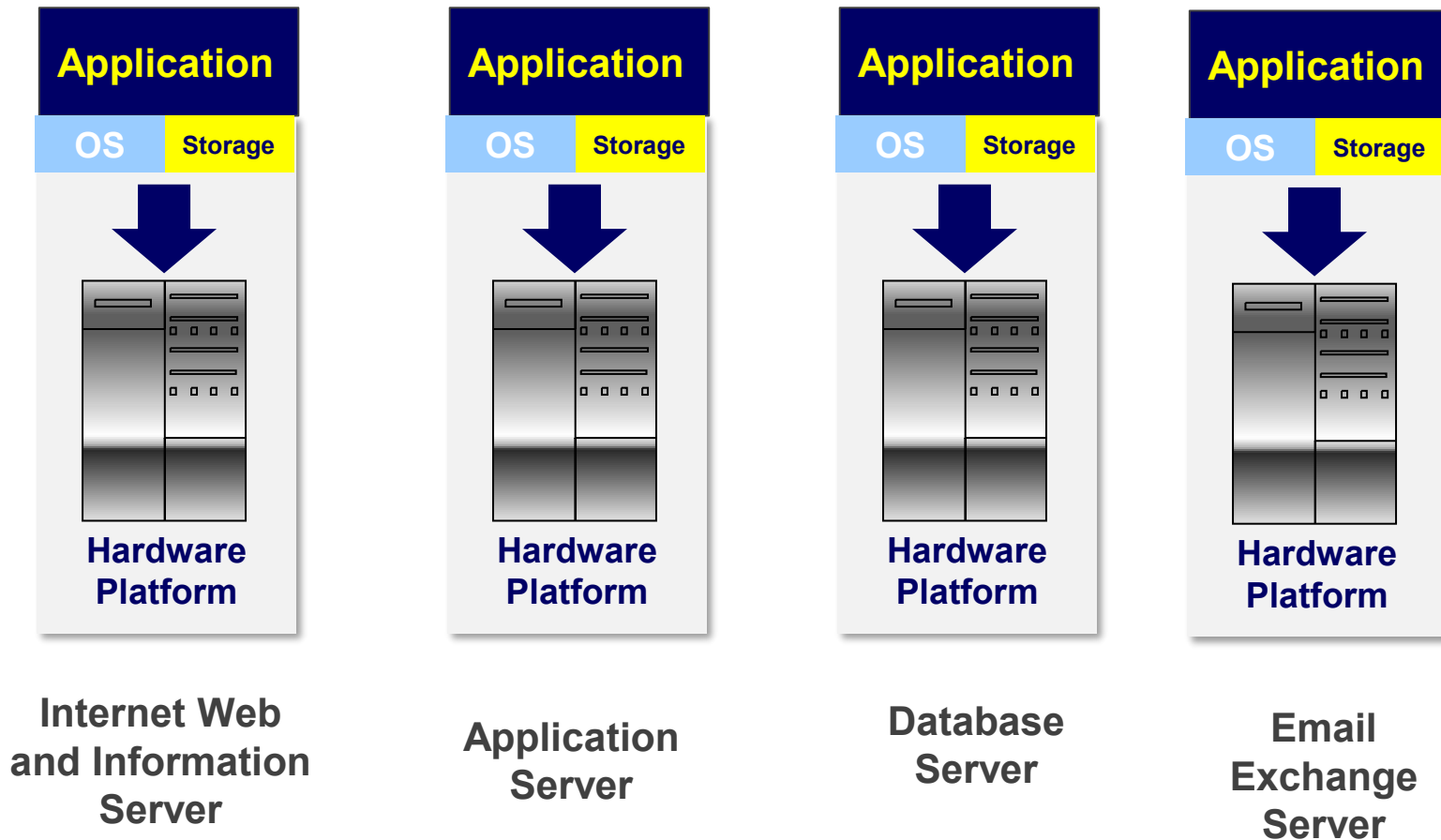


Virtualization In Practice

SERVER CONSOLIDATION

Traditional Server Infrastructure

each server has its own hardware, software and storage

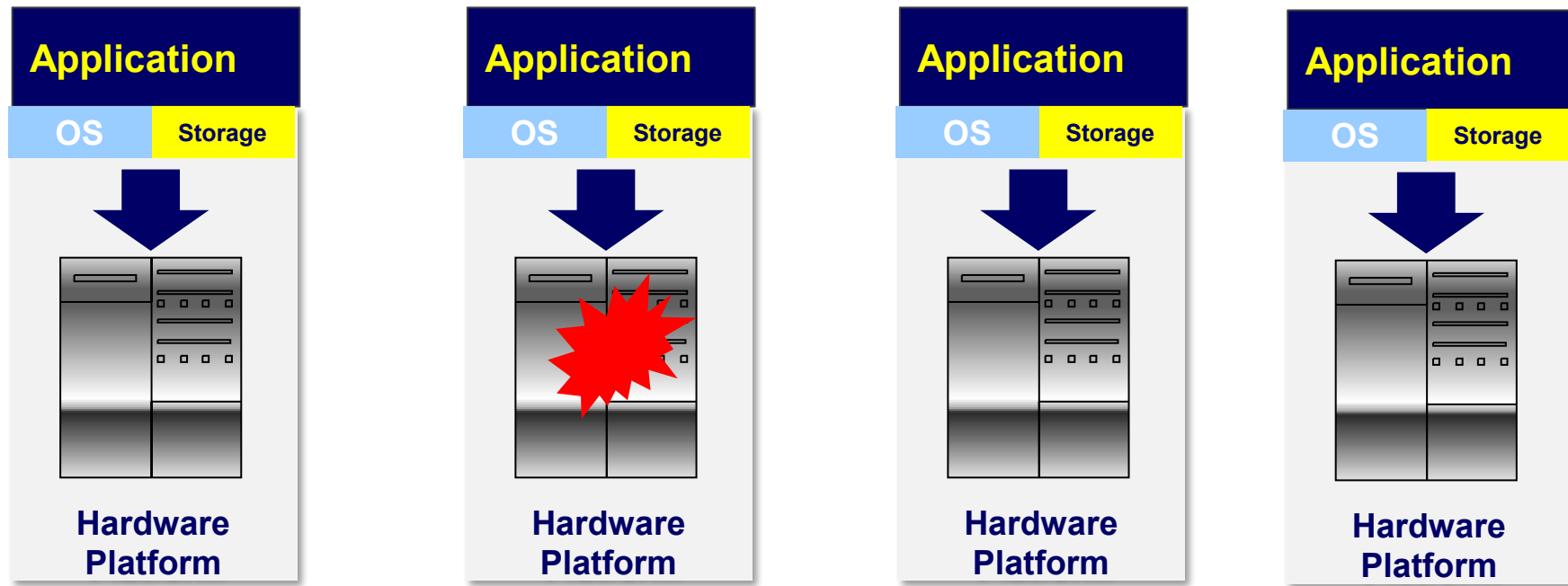




The Traditional Server Concept

- Servers are viewed as an **integral** computing unit.
 - Each unit includes the hardware, the OS, the storage, and the related applications.
- Servers are often identified and referred to by their **function**.
 - File server, Database server, SQL server, Web server Exchange server, ...
- When current server capacity reaches its limit, **a NEW server** must be added

Server Failure



Internet Web and
Information Server

Application Server

Database Server

Email Exchange
Server

A hardware failure causes service interruption

The Traditional Server Concept

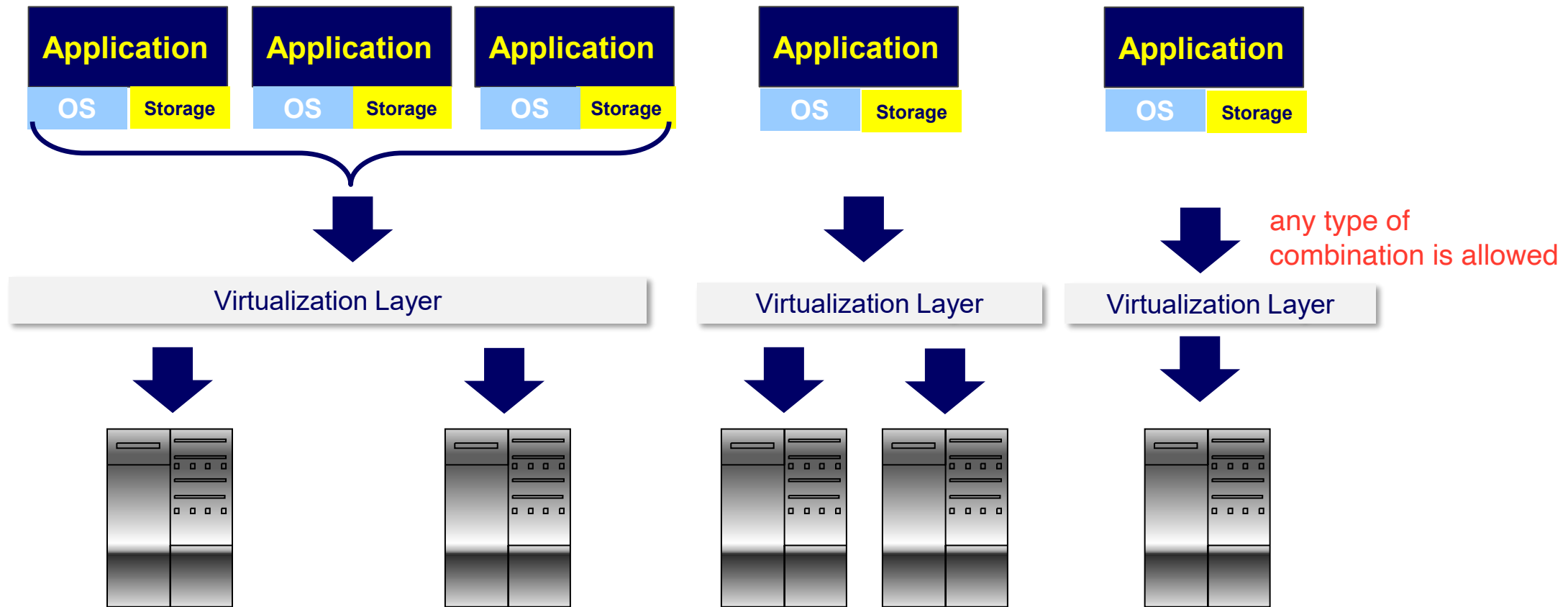
Disadvantages

- Maintenance cost is high
 - Acquisition and hardware repair cost
- Replication is challenging
 - Redundancy is costly and difficult to implement
- Scalability may be a limiting factor
- Highly vulnerable to hardware failures
- **Often, utilization is low.**

application is hard, need to find new hardware (purchase land...
if A has only use 20% storage, cannot spare to other B

virtualization separates software and hardware

Virtual Server Infrastructure



Hardware Infrastructure

Carnegie Mellon University

Server Virtualization

伺服器整合與隔離

- Server virtualization enable server Consolidation and Containment
 - Eliminating “**server sprawl**” via deployment of systems as “virtual machines” that can run safely and move transparently across shared hardware 伺服器氾濫 VM 可在不同主機間移動 (透明遷移)
- A virtual server can be serviced by one or more hosts, and one host may house more than one virtual server.
 - This results in **increased server utilization rates**
 - From 5-15%, traditional servers, to 60-80%



The Virtual Server Concept

- Virtual servers can still be referred to by their **function** i.e., email server, database server, etc.
- If the environment is built correctly, **virtual servers will not be affected by the loss of a host.**
- Hosts may be removed and introduced almost at anytime to accommodate maintenance.



The Virtual Server Concept – Cont'd

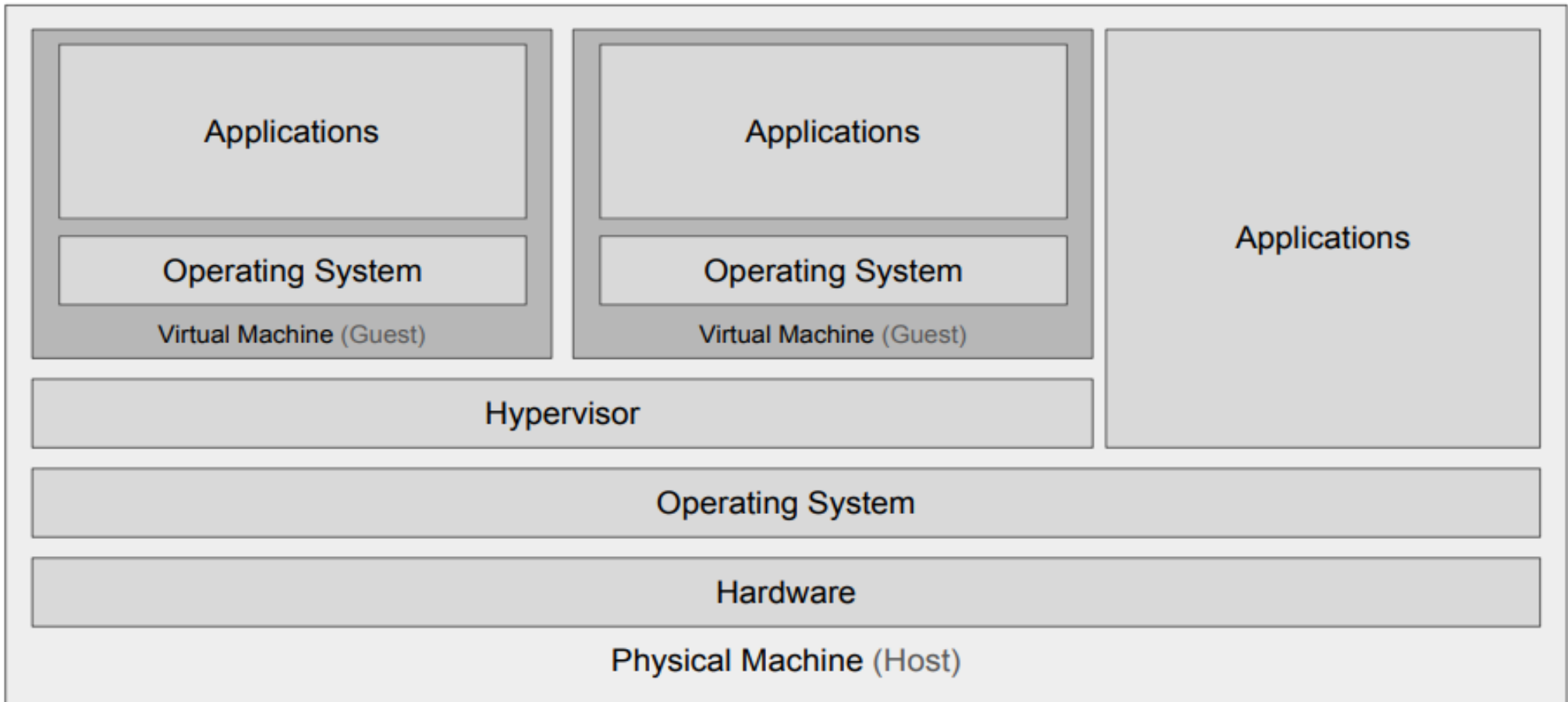
- Virtual servers can be scaled up and down easily.
 - The number of resources allocated to a virtual server can be adjusted dynamically to meet the computation requirements of the virtual server
- Server “**cloning**” can be easily achieved
 - Multiple, identical virtual servers can be easily created based on server templates
- Virtual servers can be migrated from host to host dynamically, as needed.



Virtualization Advantages

- **Resource optimization** that would result in reducing hardware, power and space requirement.
- Virtualization allows for the **quick deployment, migration, and replication** of VMs.
- **Support for Legacy Systems**: Virtualization allows legacy applications to run in a modern cloud environment without requiring significant changes to the underlying infrastructure
- Better **automation**.

Virtualization – How it may look like?!

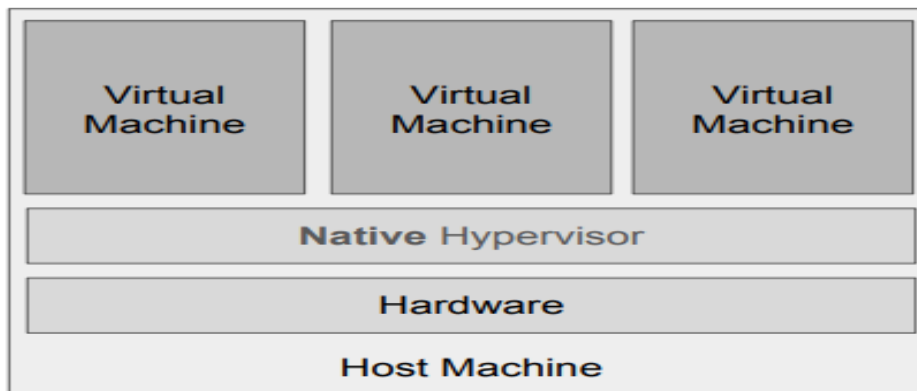


Is this the only form of Virtualization?

Hypervisors

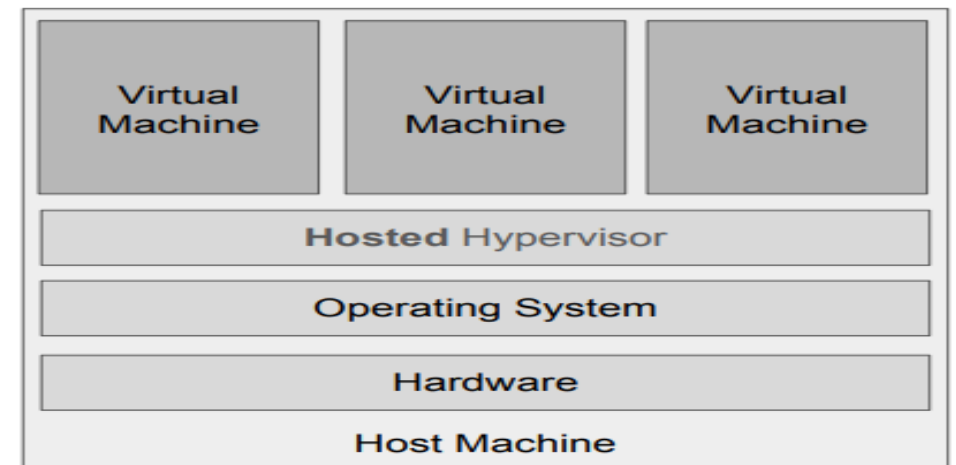
Type 1: Native Hypervisors

- Runs directly on the host machine and shares resources (such as memory and devices) among guest machines
- **Examples:** VMware ESX and XEN.



Type 2: Hosted Hypervisors

- Runs as an application inside an operating system and supports virtual machines running as individual processes.
- **Examples:** VirtualBox, QEMU, JVM and UTM.





Lab – Use Hosted Supervisors



Virtual Resources In the Cloud

- **Network virtualization** is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network
 - External Network Virtualization - VLAN
 - Internal Network Virtualization – Software defined network
- **Storage virtualization** pools physical storage from multiple network storage mediums to enable a single logical storage pool that is managed from a central console. This topic will be discussed in a later lecture.

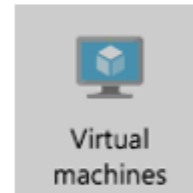
VMs in the Cloud

- Getting VMs from

- AWS EC2

- Azure

- Google Cloud





In-class Demo

Create VMs on GCP

Google Cloud Coupons will be provided next week



Next Steps

- Install Docker on your machine
<https://www.docker.com/products/docker-desktop>



Reading

- Read the article “Physical server vs. Virtual machine: The Choice is open”
 - <https://www.bdrsuite.com/blog/physical-server-vs-virtual-machine-choice-open/>

Waitlisted Students

- All materials for first two weeks will be uploaded here

