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

What is Virtualization?

- 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!
  - Virtual resources can be started and stopped easily and quickly.

Virtualization - Definitions

Virtualization

- The process of creating a virtual version of a physical object.

Virtual Machine

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

Virtual Machine Monitor (VMM) or Hypervisor

- 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.

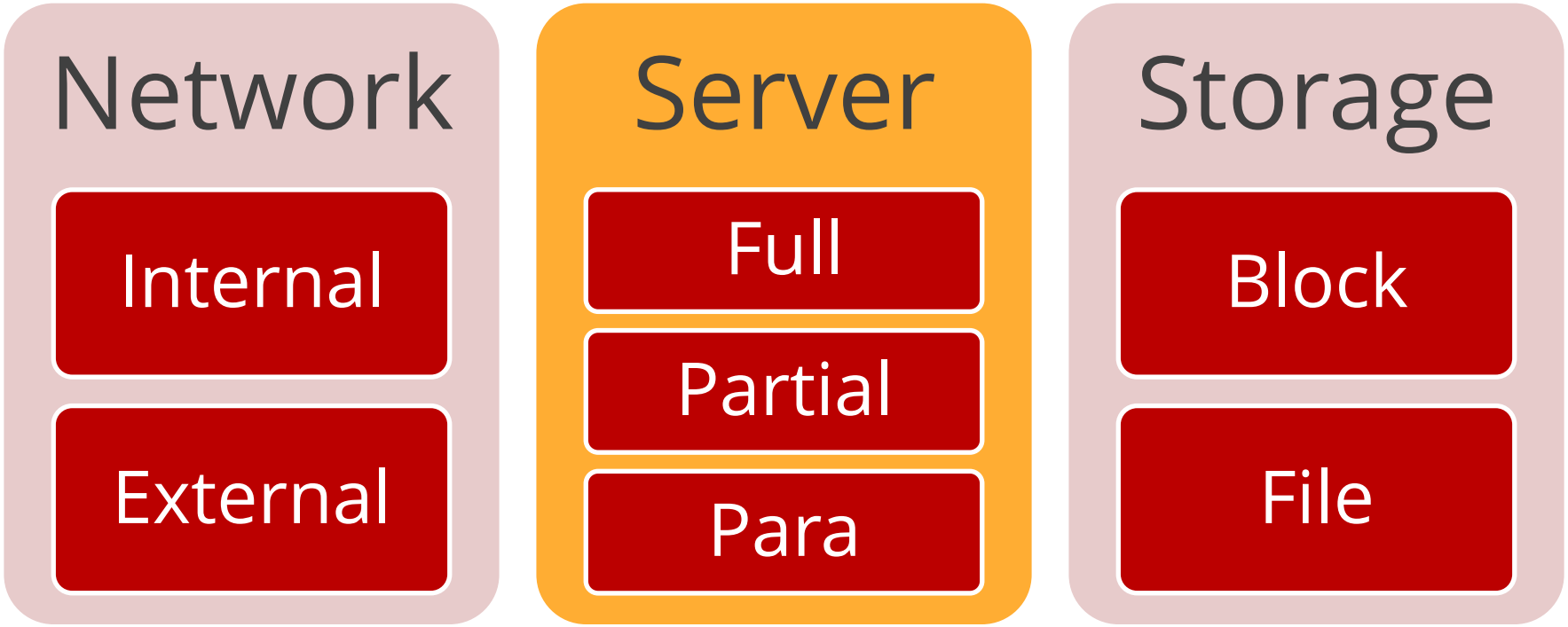
Guest Machine

- 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

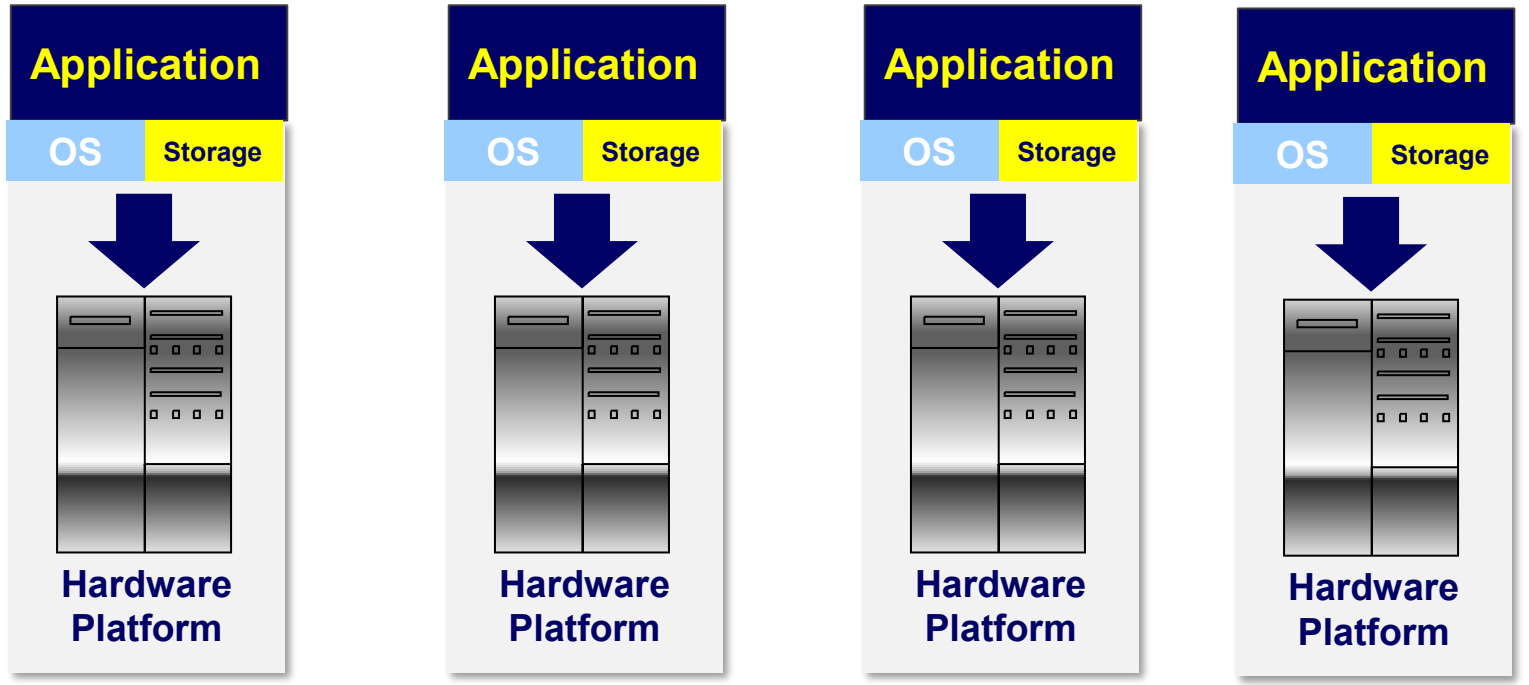
Most Important Virtualization Types



Virtualization In Practice

SERVER CONSOLIDATION

Traditional Server Infrastructure



Internet Web and Information Server

Application Server

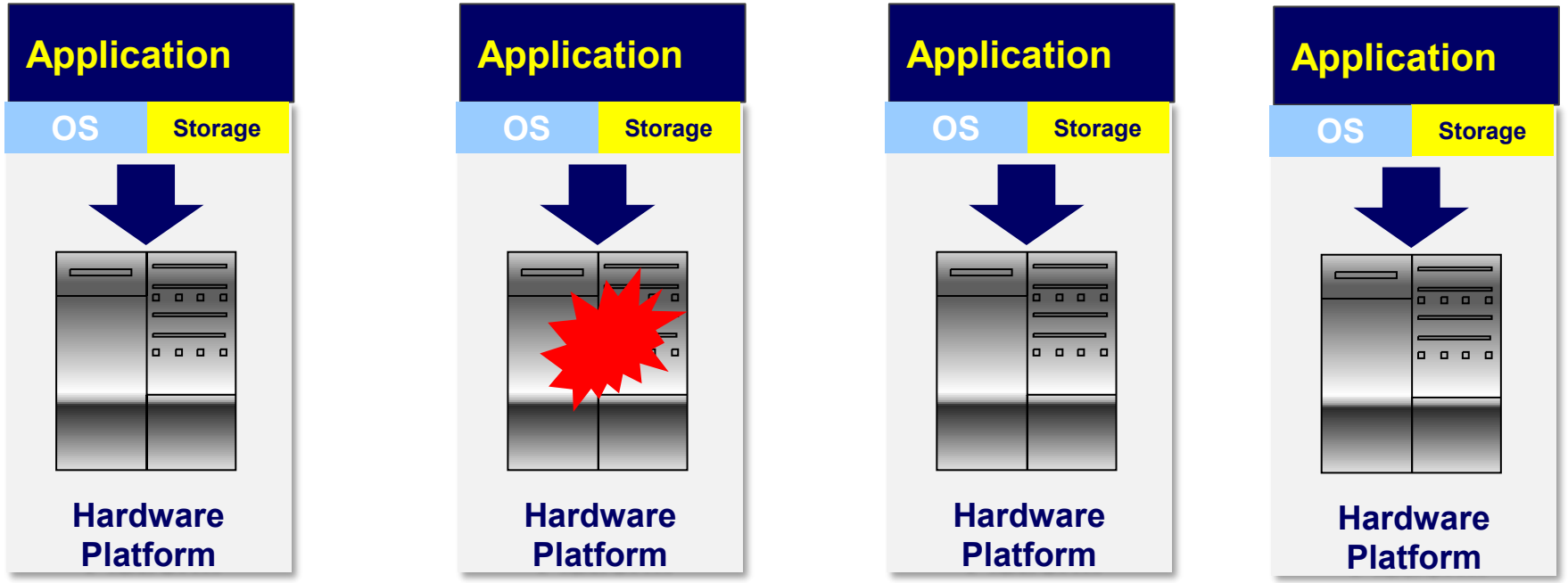
Database Server

Email Exchange Server

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

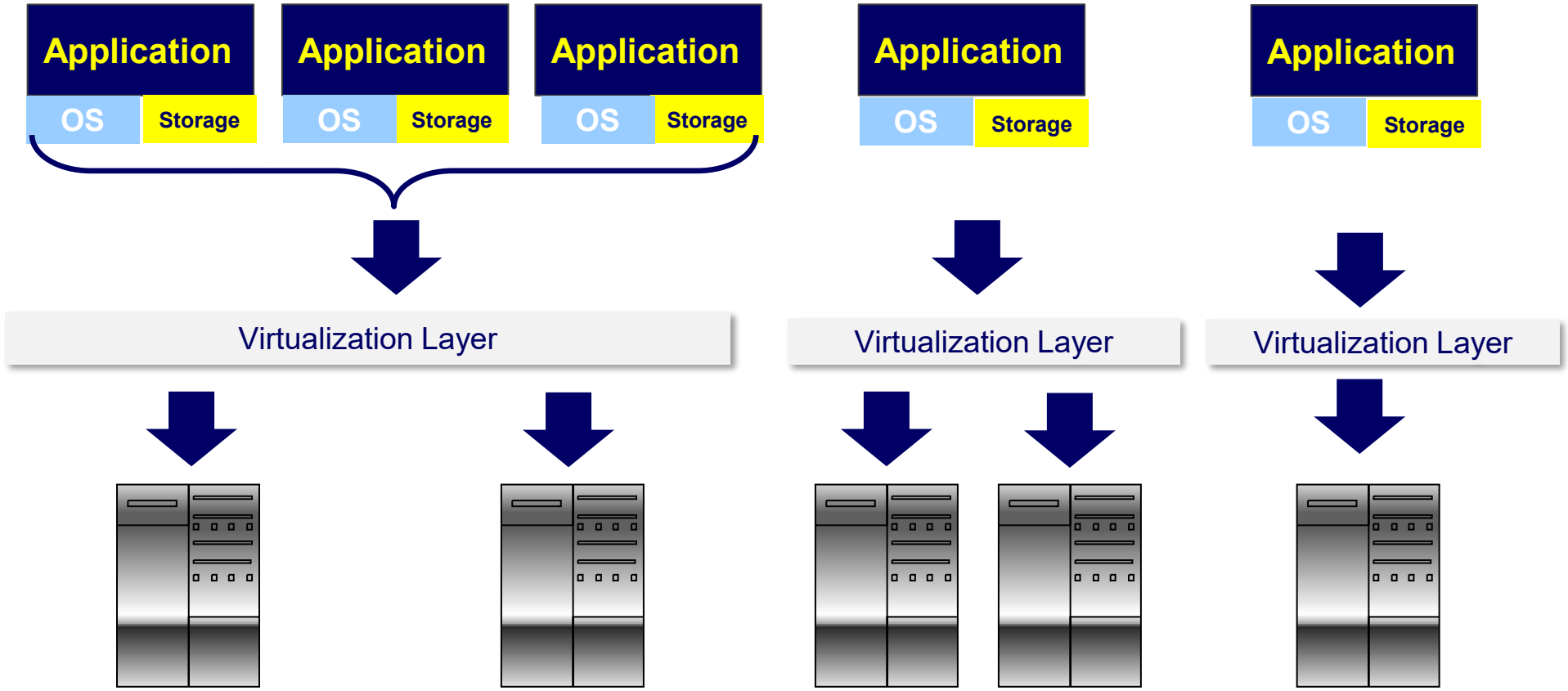
A hardware failure causes service interruption

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.**

Virtual Server Infrastructure



Server Virtualization

- 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
- 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.

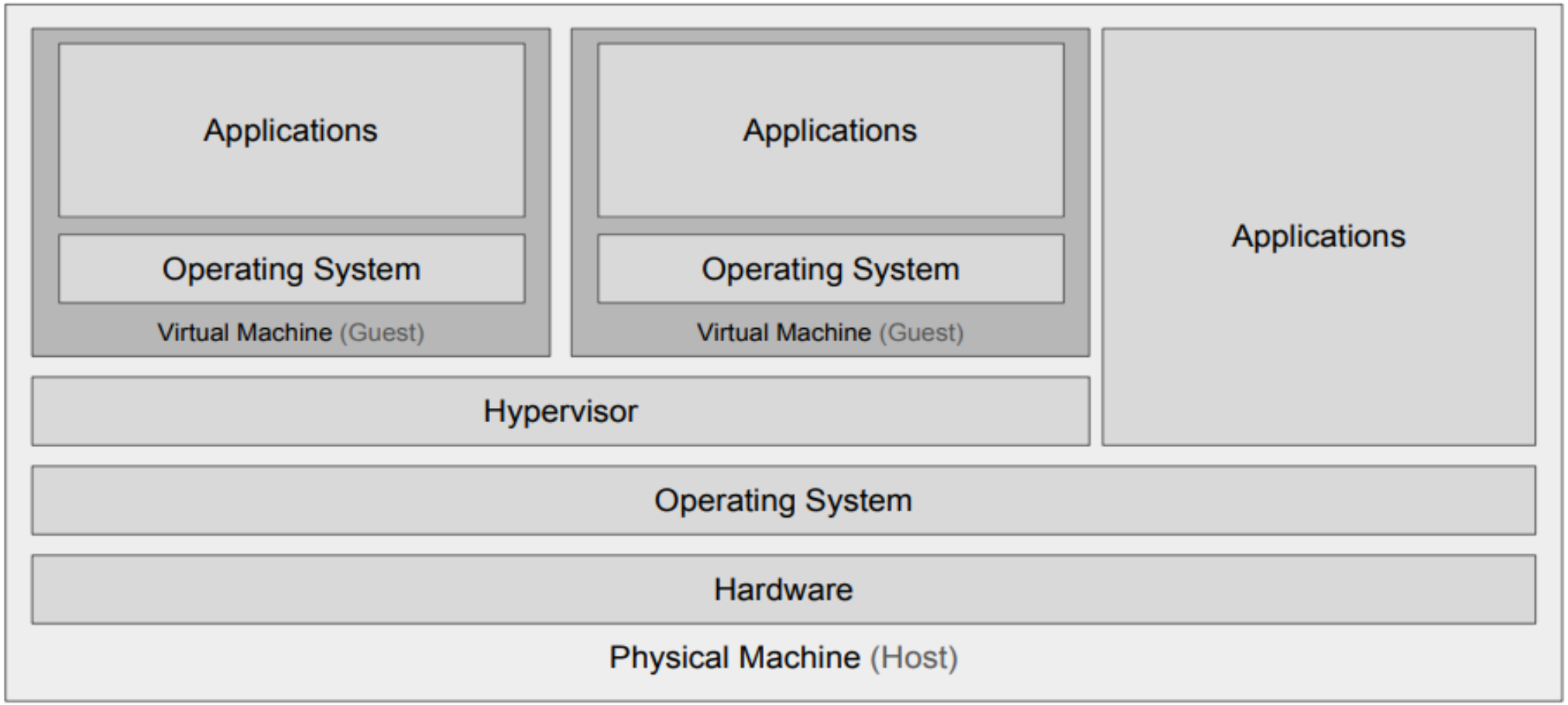
The Virtual Server Concept – Cont'd

- 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?!

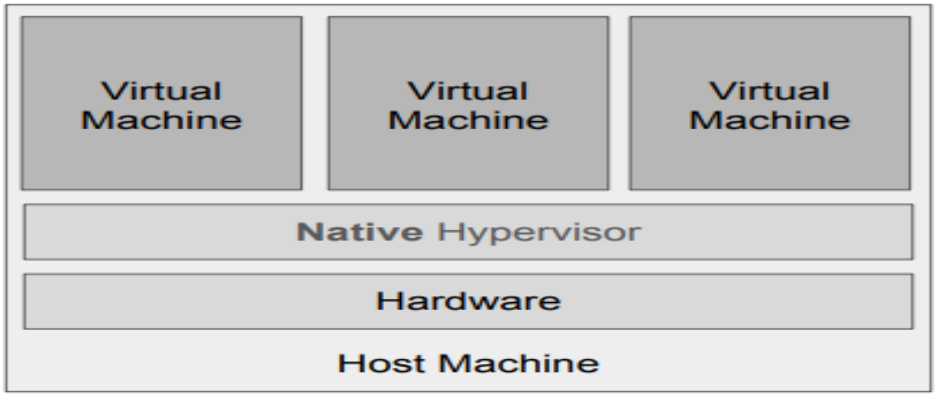


Is this the only form of Virtualization?

Hypervisors

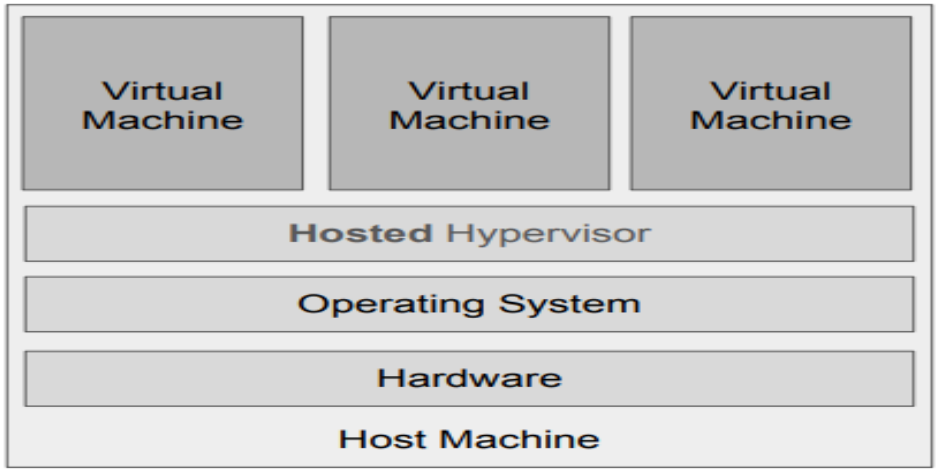
Type 1: Native Hypervisors

- 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