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 & Create AWS Account

Why to study Virtualization?

Cloud Computing = Data Center + Virtualization

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

Roots of Virtualization

- Technology evolution both drives and is driven, by ever increasing levels of abstraction in hardware and software
- High-level programming language allow software development, while shielding programmers away from the complexity of OS
- OS provides a lower level of abstraction that frees software developers from the complex and varied details to interact with and manage physical resources such as memory and I/O devices
  - OS must be fully cognizant of the hardware on which it resides

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 Computing!
  - 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

Network
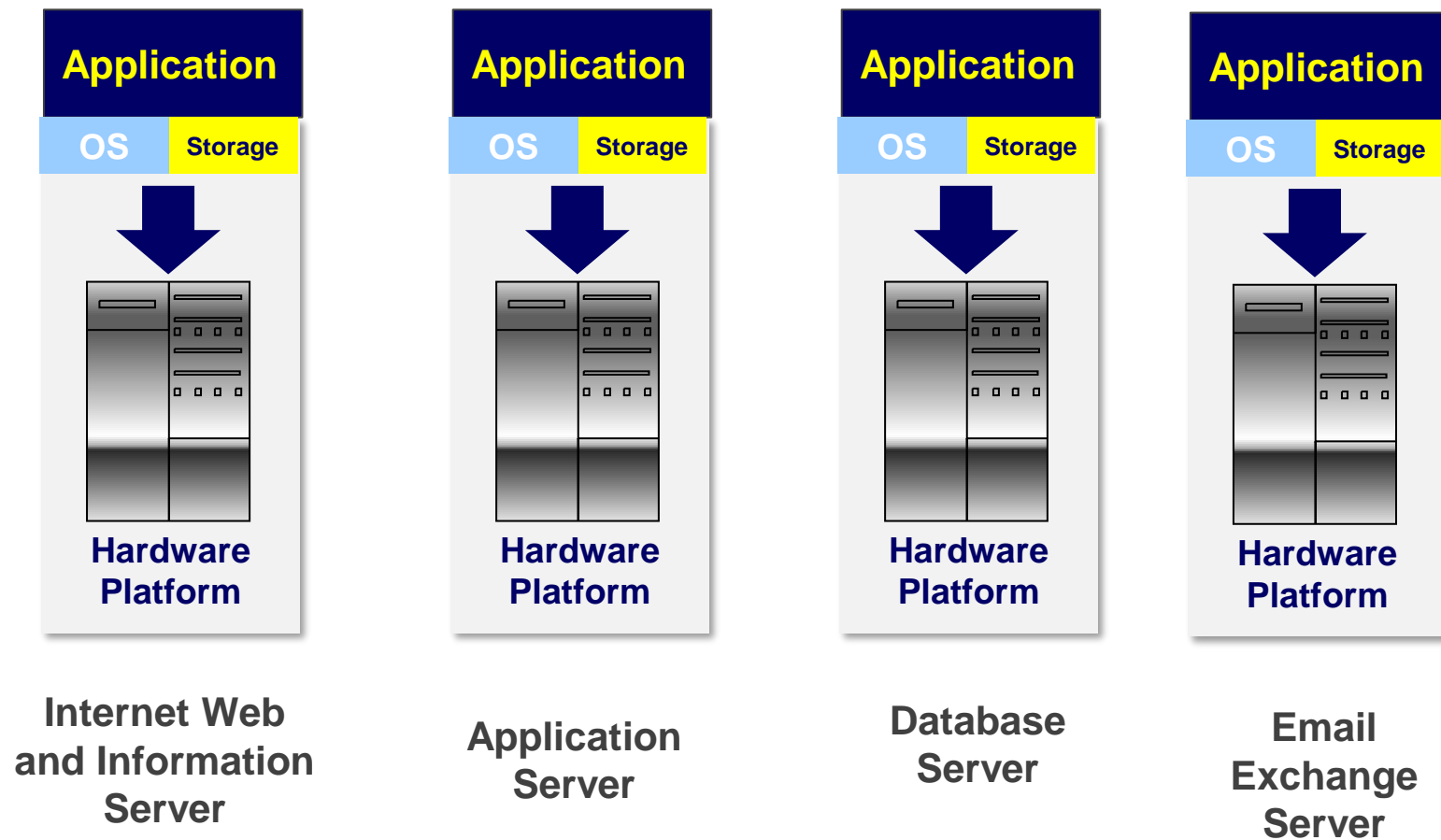- Internal
- External

Server
- Full
- Partial
- Para

Storage
- Block
- File

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Virtualization In Practice

SERVER CONSOLIDATION

Traditional Server Infrastructure

Application | **OS** | **Storage** | **Hardware Platform**
Internet Web and Information Server

Application | **OS** | **Storage** | **Hardware Platform**
Application Server

Application | **OS** | **Storage** | **Hardware Platform**
Database Server

Application | **OS** | **Storage** | **Hardware Platform**
Email Exchange Server

The Traditional Server Concept

- Servers are viewed as an **integral** computing unit

  - The unit includes the hardware, the OS, the storage, and the 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
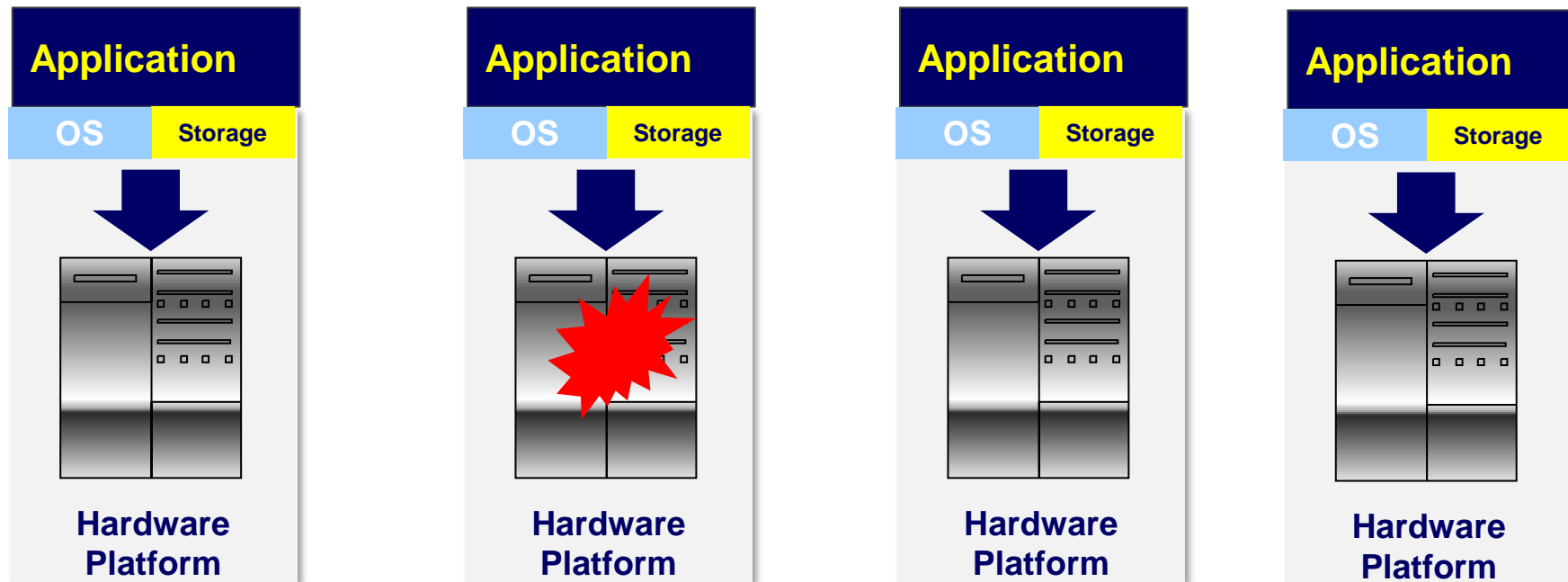
| Internet Web and Information Server | Application Server | Database Server | Email Exchange Server |

A hardware failure causes service interruption
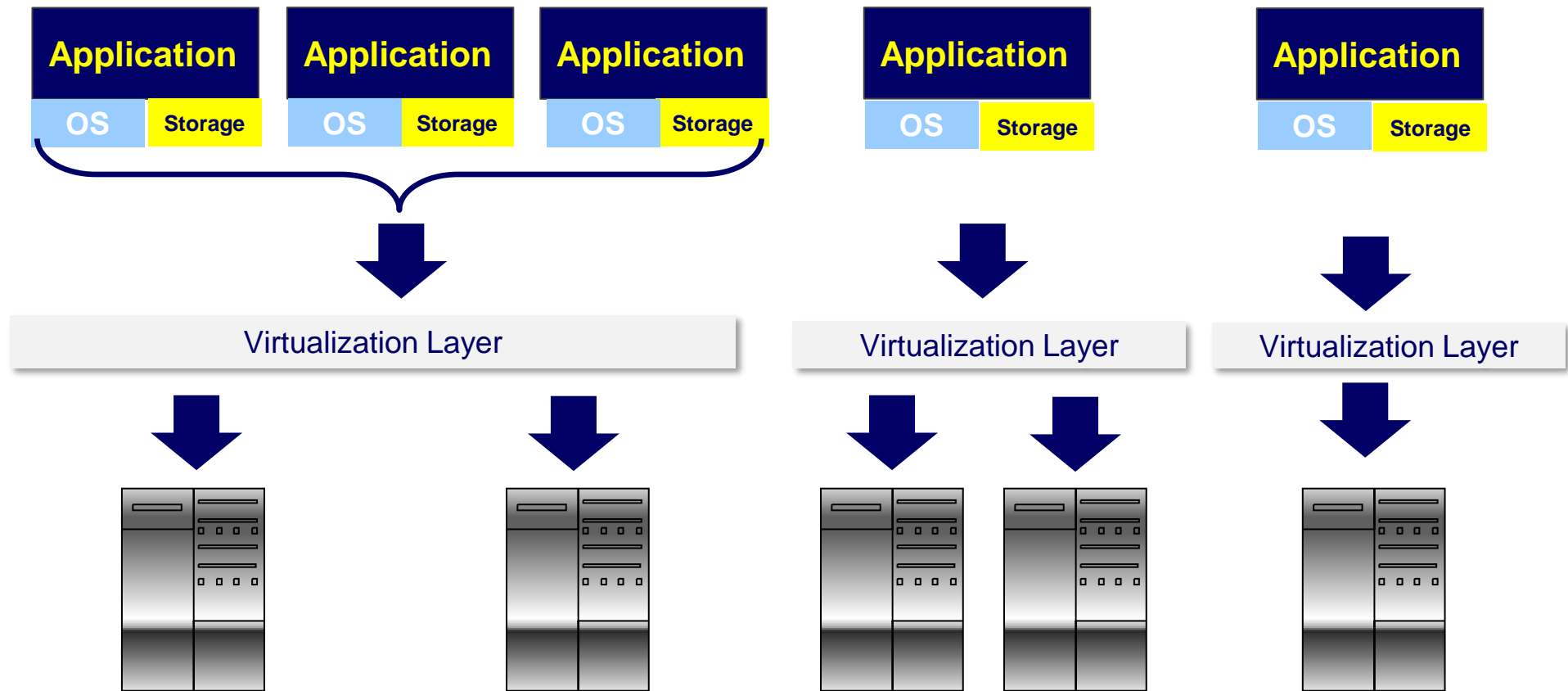
The Traditional Server Concept

Advantages

- Ease of configuration and conceptualization

- Ease of deployment

- Backup is manageable

- The client-server paradigm is well-suited for a variety of applications and services. Virtually, any application or service can be deployed on such a computing infrastructure

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

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Virtual Server Infrastructure

Application	Application	Application	Application	Application
OS Storage	OS Storage	OS Storage	OS Storage	OS Storage

Virtualization Layer

Virtualization Layer

Virtualization Layer

Hardware Infrastructure

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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 will to accommodate maintenance.

The Virtual Server Concept – Cont'd

- Virtual servers can be scaled out easily.

    - Amount 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.

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Virtualization Advantages

- Workload consolidation to reduce hardware, power and space requirement
- Ability to run multiple OSs, and leverage their advantages based on the application
  - Run legacy software on more efficient, modern architecture
  - Dynamically migrate workloads to provide fault tolerance
- Provide redundancy to mitigate disasters
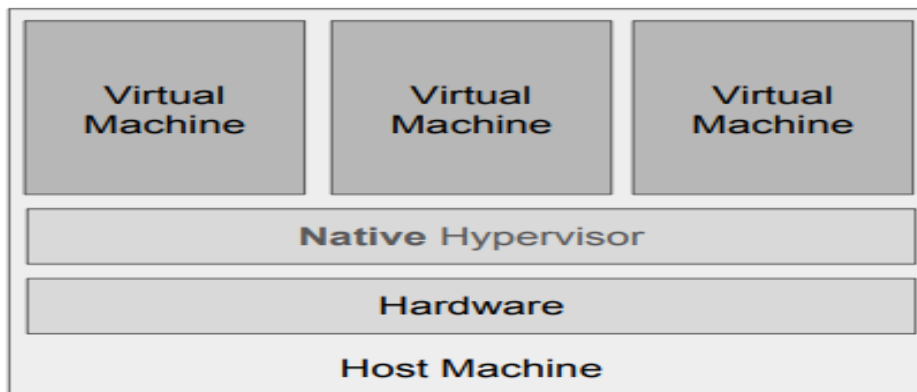- Greater automation

Virtualization – How it may look like?!
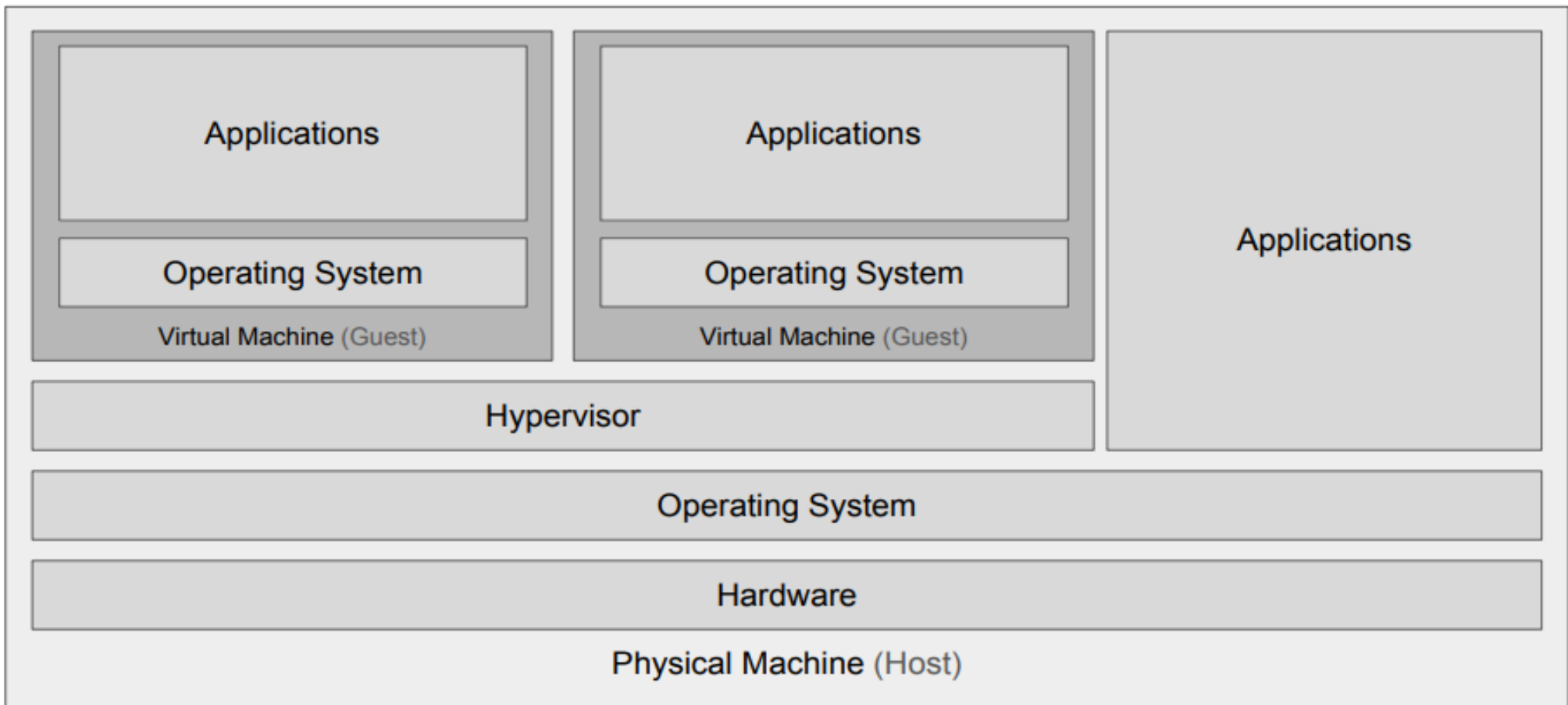
Is this the only form of Virtualization?

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.
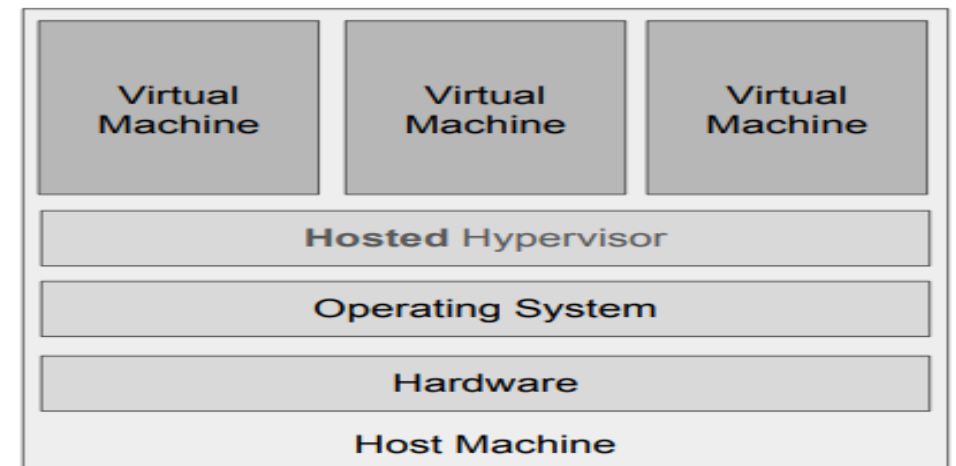
Lab – Use Hosted Supervisors

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 to enable a single storage device that is managed from a central console. This topic will be discussed in a later lecture.
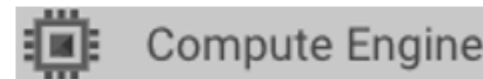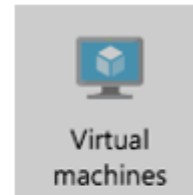
VMs in the Cloud

- Getting VMs from

  - AWS EC2

  - Azure

  - Google Cloud

Lab – 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

- Create AWS Account using school email address
  https://aws.amazon.com/resources/create-account/

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/