



# 14-848 Cloud Infrastructure

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LECTURE 2

VIRTUALIZATION

# Agenda

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- 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?

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Cloud Infrastructure = Data Center + Virtualization

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

# What is Virtualization?

layer over physical hardware

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- Virtualization abstracts the hardware of computing infrastructure into several different execution environments.
  - It creates the illusion that each separate <sup>execution environment</sup> 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

thin client

service packs patches

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## 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

software / application

- 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?

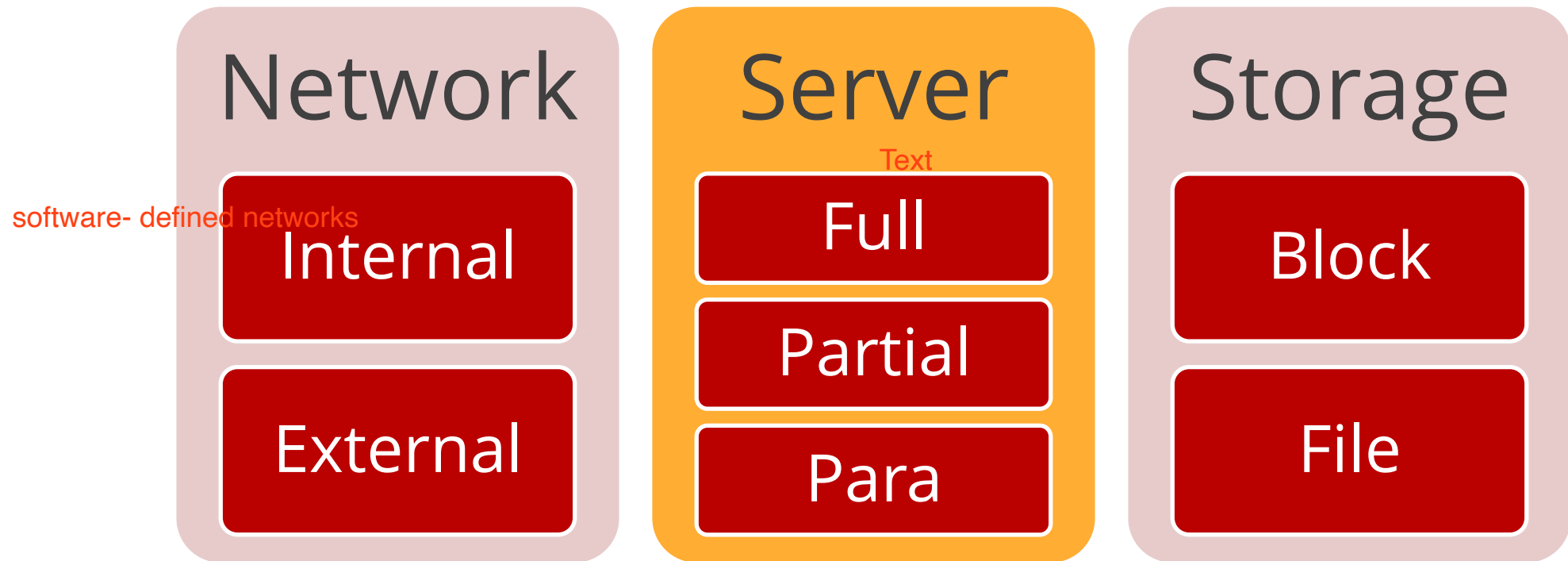
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The following video answers this question:

[https://www.youtube.com/watch?v=vUUC\\_eDb2z0](https://www.youtube.com/watch?v=vUUC_eDb2z0)

# Most Important Virtualization Types

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# **Virtualization In Practice**

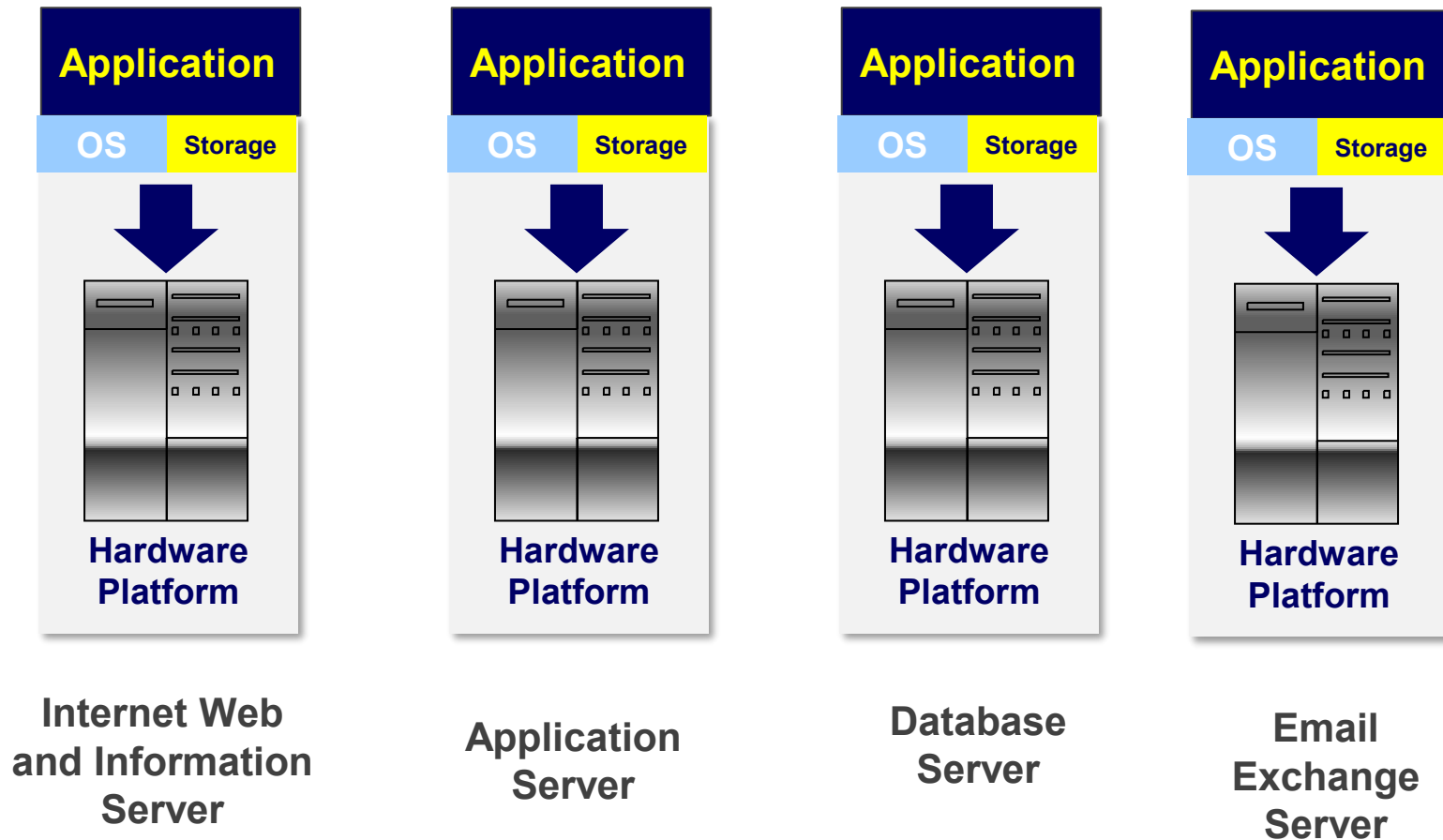
## **SERVER CONSOLIDATION**



hardware(server) failure -> service interruption

server prompt

# Traditional Server Infrastructure



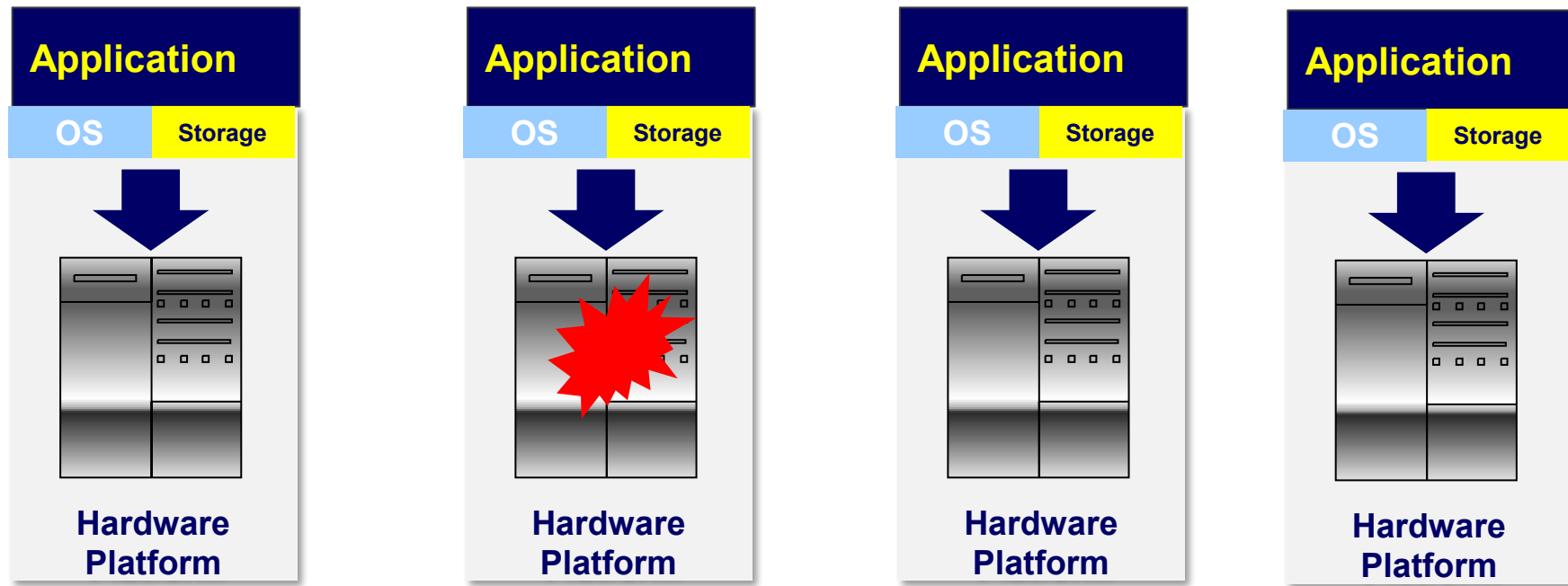
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# The Traditional Server Concept

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- 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

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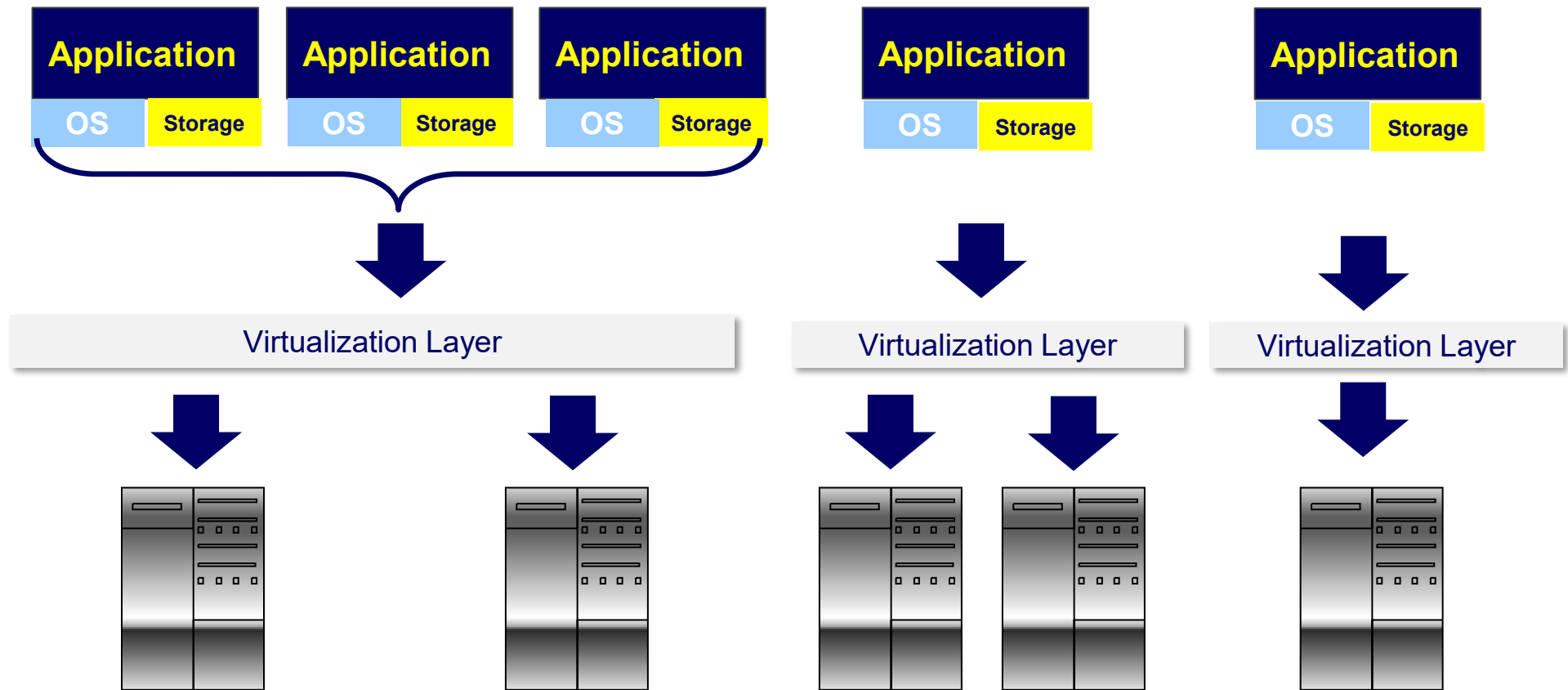
## Disadvantages

- 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.

storage: not reallocate to another server



# Virtual Server Infrastructure



**Hardware Infrastructure**

# Server Virtualization

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- 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 have available resources somewhere ealse but cannot use
- 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

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- Virtual servers can still be referred to by their **function** i.e., email server, database server, etc. software component
- 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

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- 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.



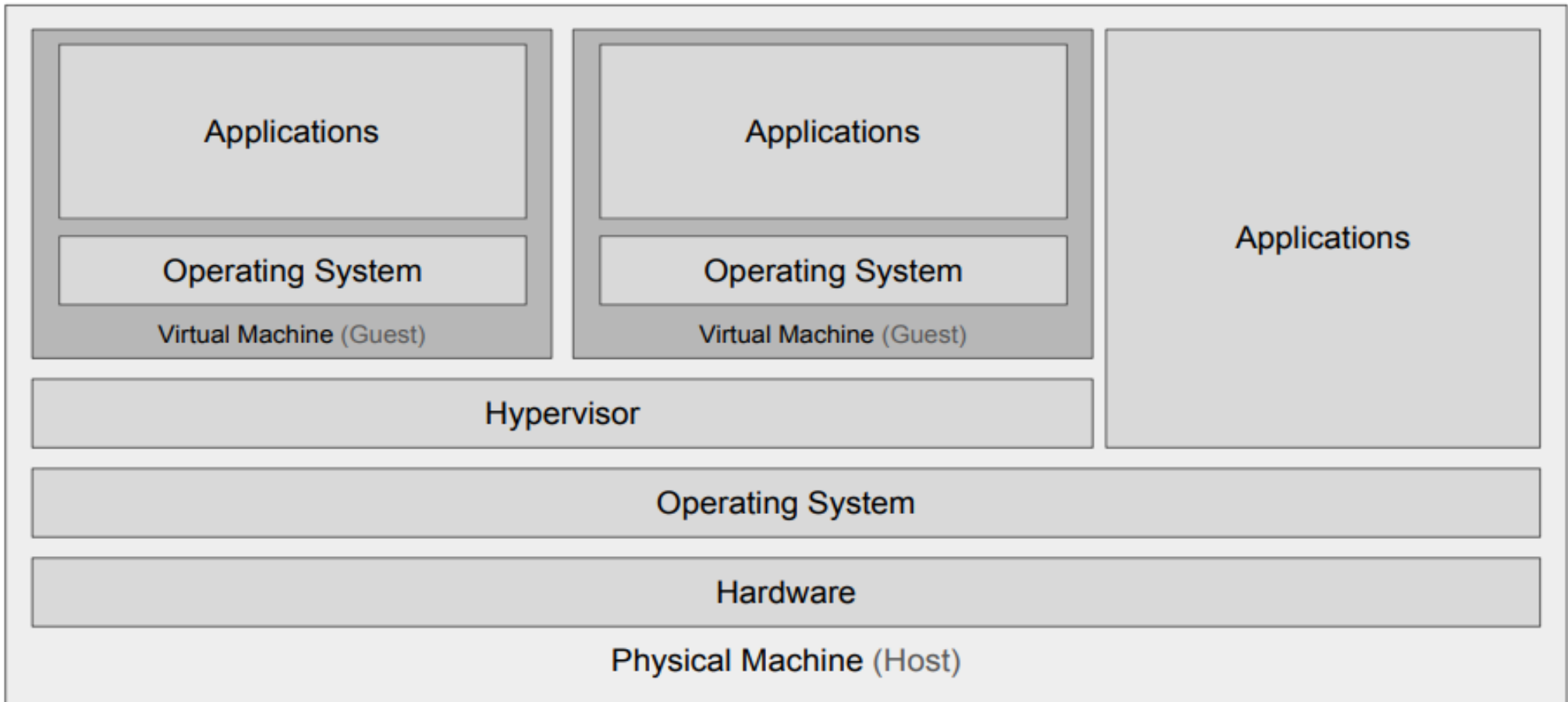


# Virtualization Advantages

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- **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?!

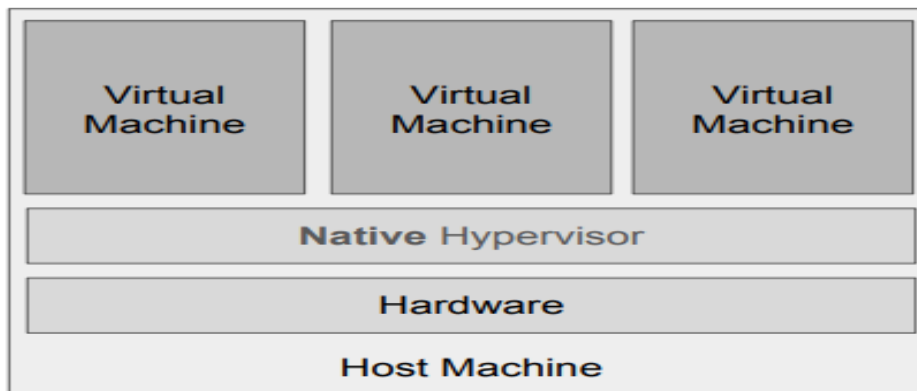


Is this the only form of Virtualization?

# Hypervisors

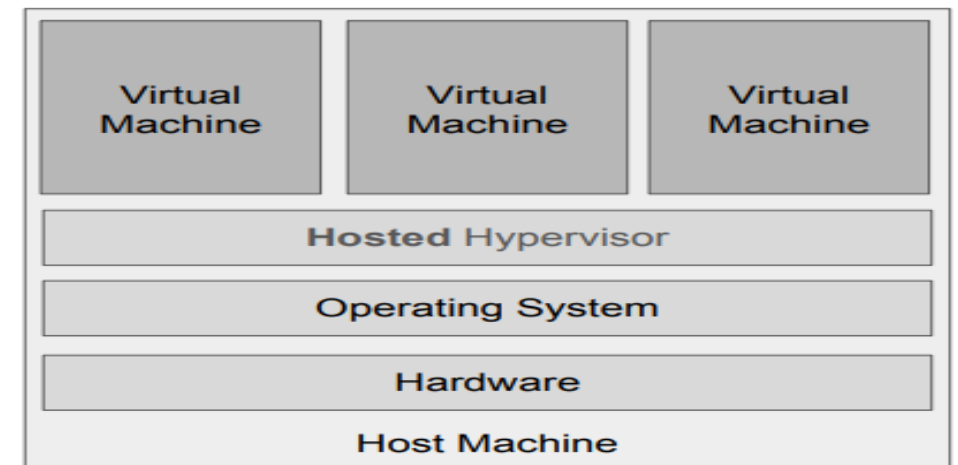
## Type 1: Native Hypervisors

- 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

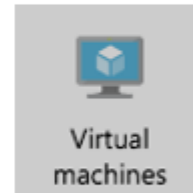
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- **Network virtualization** is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network
  - External Network Virtualization - VLAN
  - Internal 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

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- 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

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





# Reading

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- 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

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- All materials for first two weeks will be uploaded here

