14-848 Cloud Infrastructure

VIRTUALIZATION

Agenda

- Why Virtualization is Important?
- What is Virtualization?
- Traditional Server Infrastructure
- Virtual Server Infrastructure
- Hypervisors
- Virtual Servers on the Cloud
- Next Steps – AWS Training

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

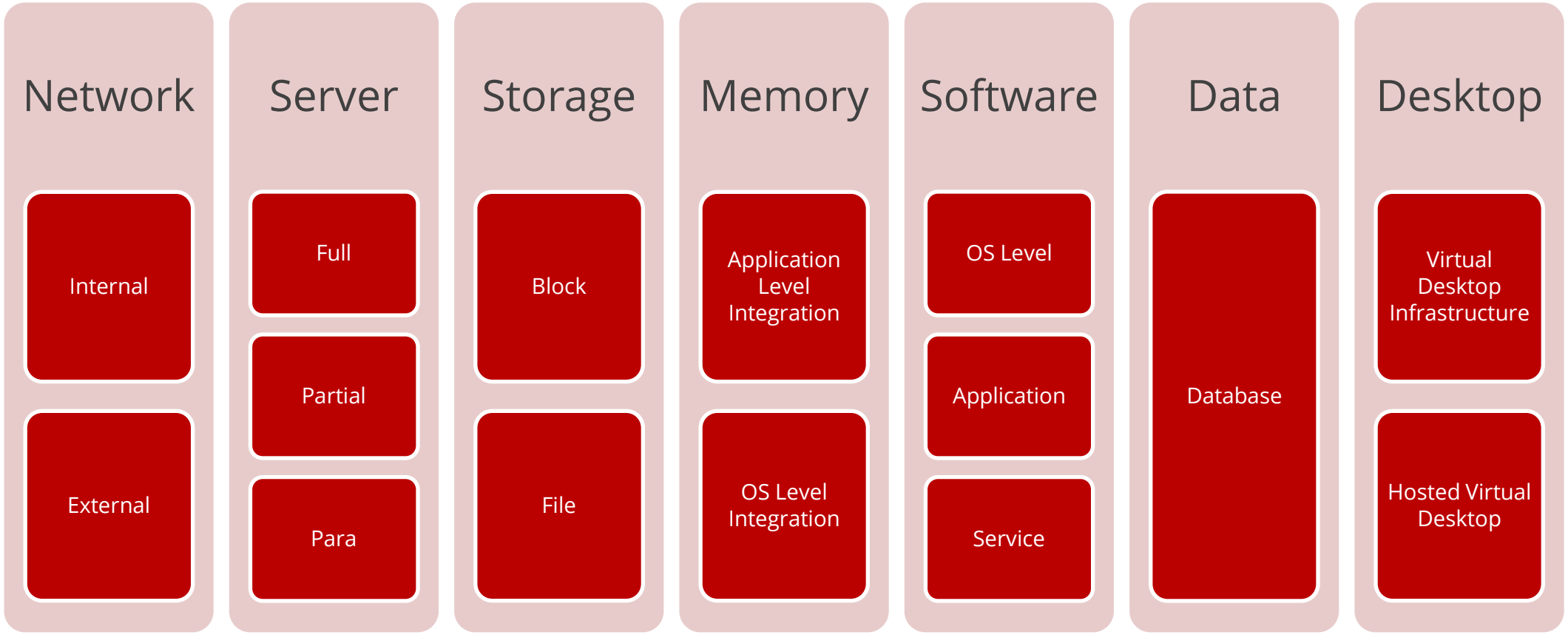
- The virtual machine, running on the host machine.

Why Virtualization is Important?

The following video answers this question:
https://www.youtube.com/watch?v=vUUC_eDb2z0

time, energy, data loss, security

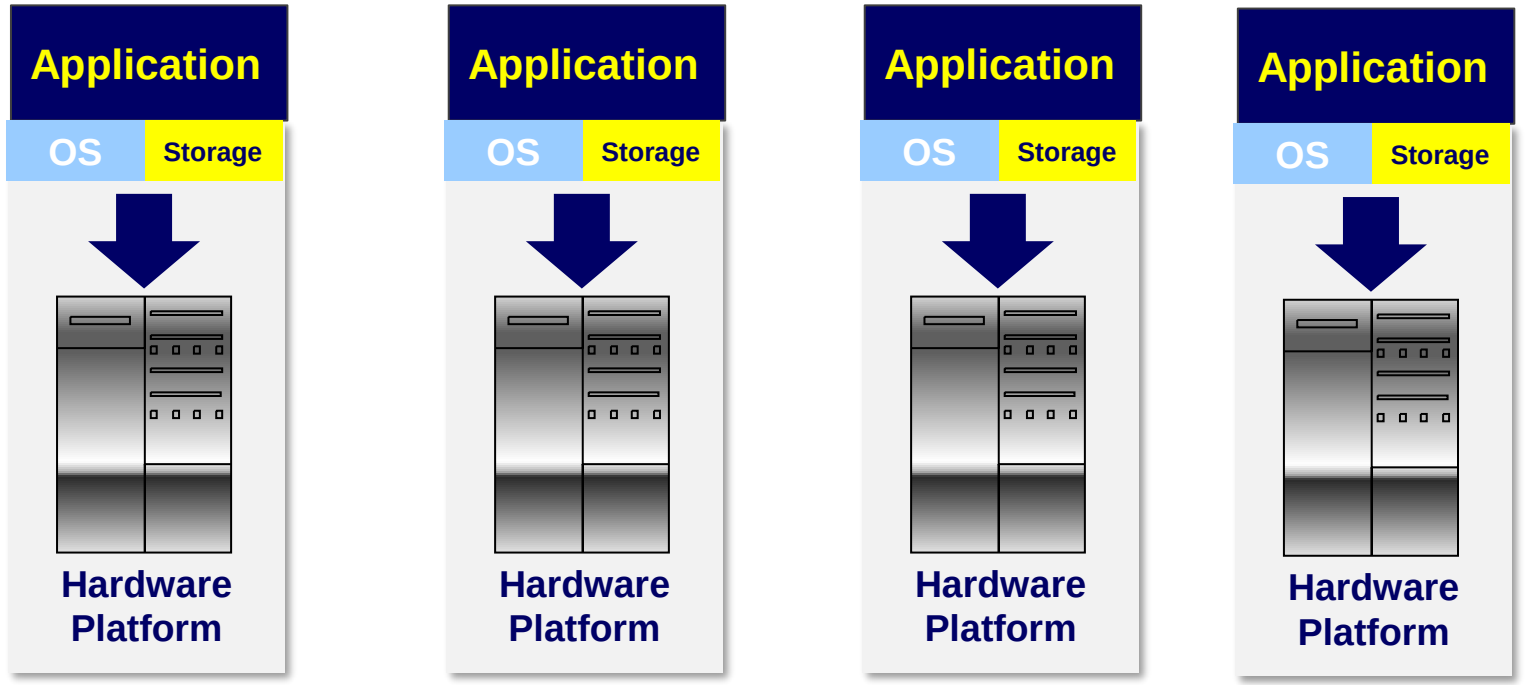
Virtualization Types



Virtualization In Practice

SERVER CONSOLIDATION

Traditional Server Infrastructure



Internet Web and Information Server

Application Server

Database Server

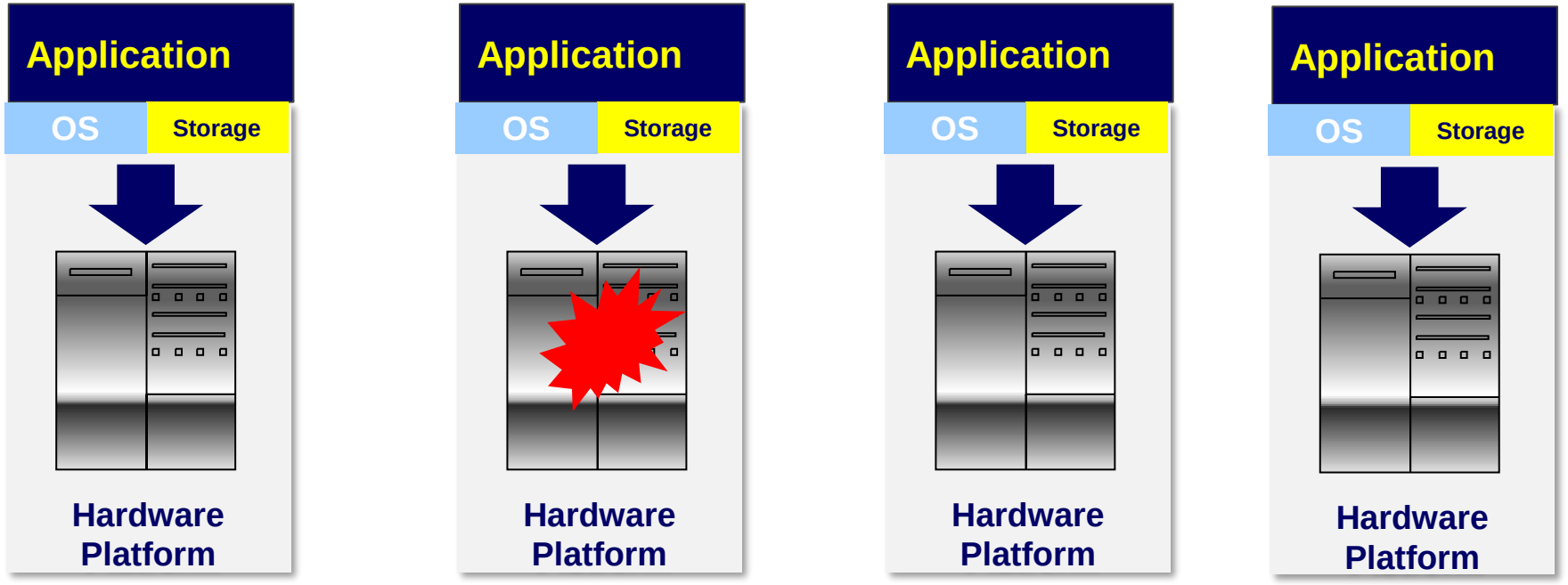
Email Exchange Server

The Traditional Server Concept

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

it cannot access other server's storage

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

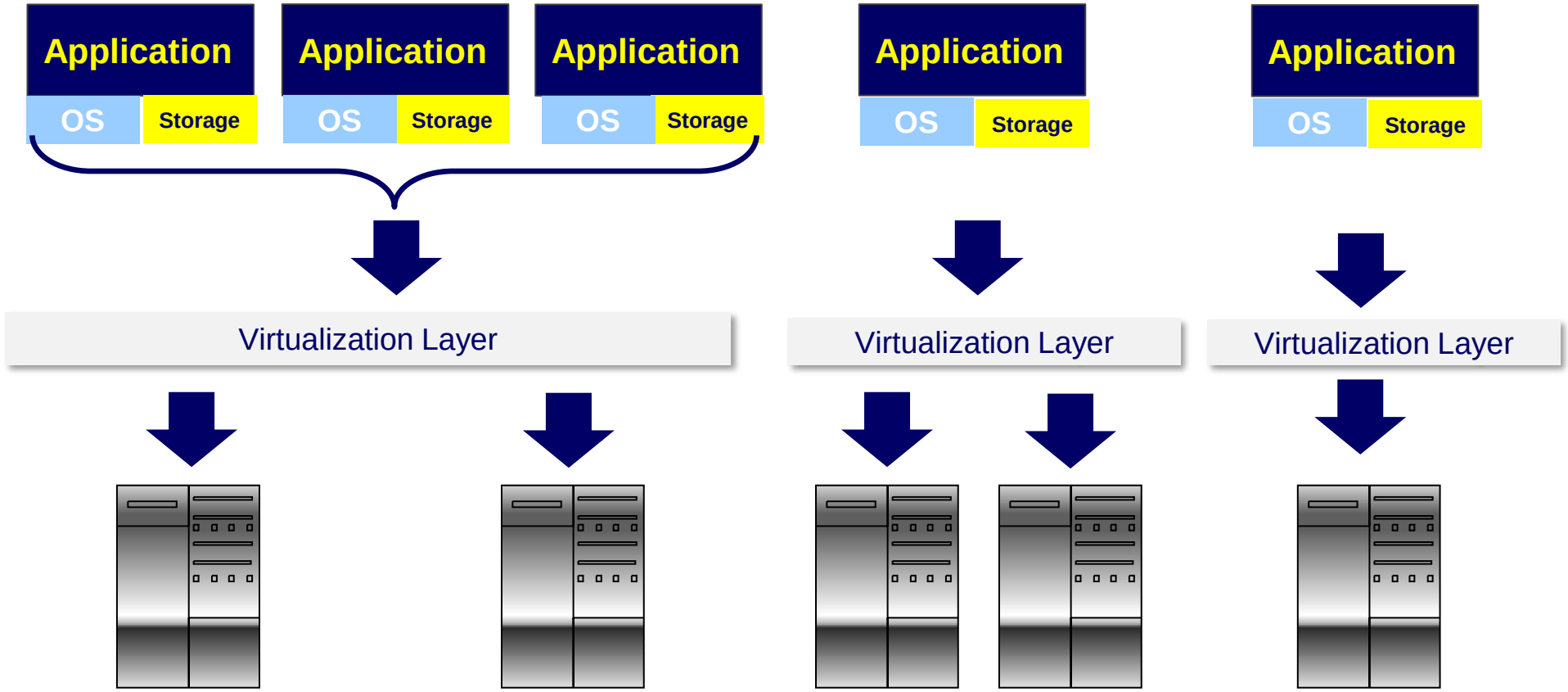
predictable users

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

virtualization can have the problem of sharing the same hardware with other company (legal problem)



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. final exam?
  - 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

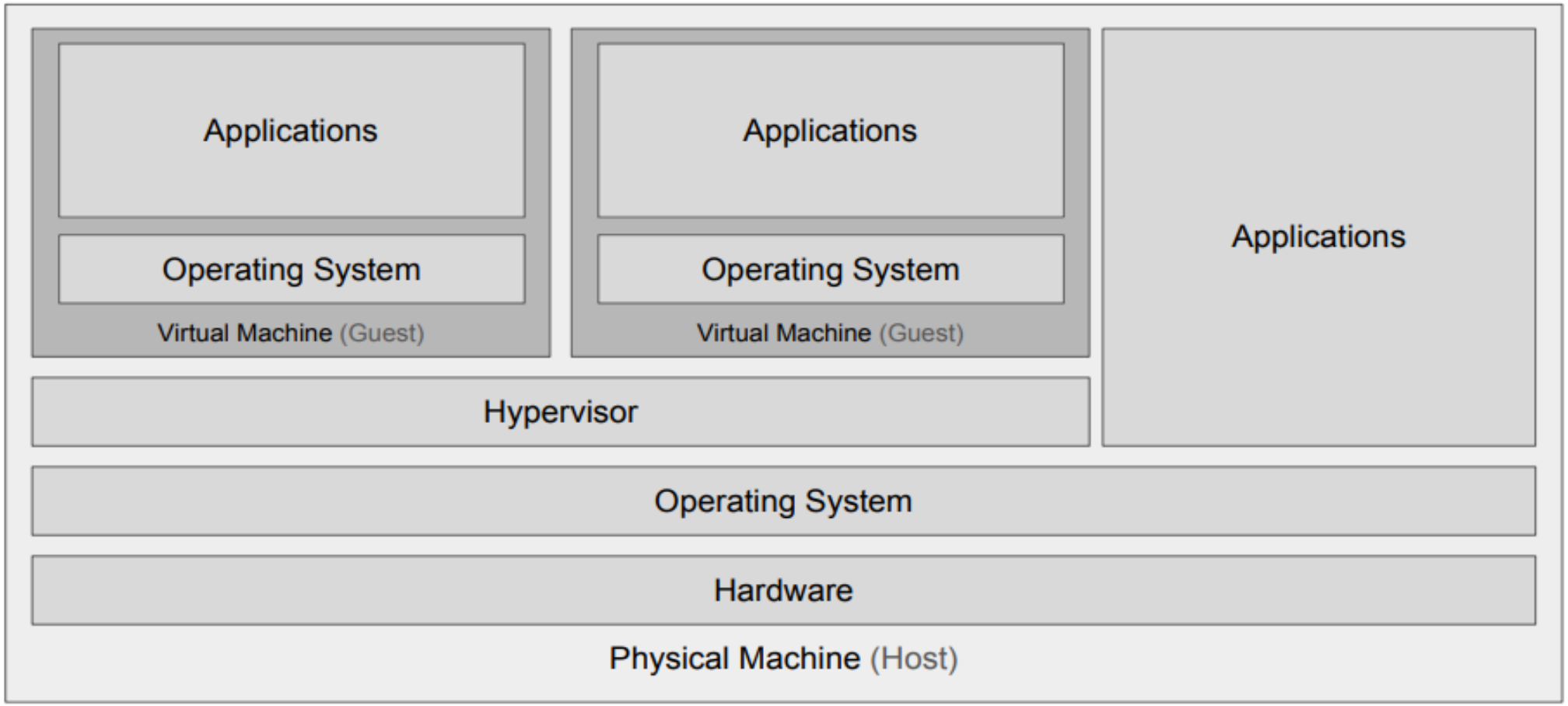
- Virtual servers can be scaled out easily.
  - Amount of resources allocated to a virtual server can be adjusted dynamically to meet the computation requirements of the virtual server
- Server "**cloning**" can be easily achieved
  - Multiple, identical virtual servers can be easily created based on server templates
- Virtual servers can be migrated from host to host dynamically, as needed.

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

disability: security, not all software can be virtualized(e.g. lockdown browser)

Virtualization – How it may look like?!

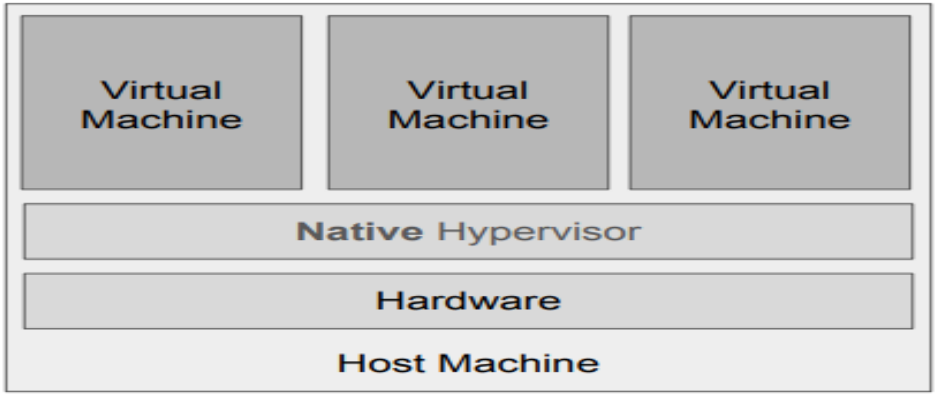


Is this the only form of Virtualization?

Hypervisors

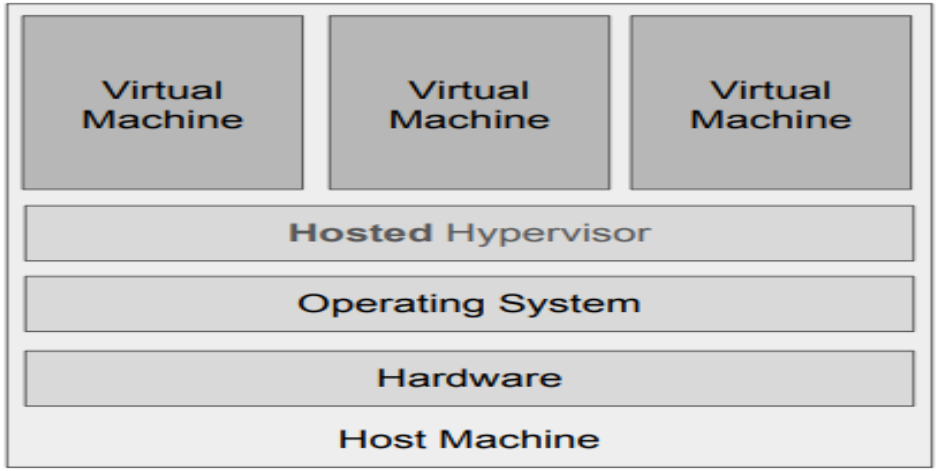
Type 1: Native Hypervisors

- 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, and JVM.



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

VMs in the Cloud

- Getting VMs from
  - AWS EC2
  - Azure
  - Google Cloud

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/

- Python Tutorials module is now available on Canvas
  - Waitlisted students who need Python help can watch the tutorials upon joining the class

Next Steps

- **AWS Training is offered live for our class this Thursday 11am ET/8am PT**. You will learn important practices for your AWS usage. e.g., how to monitor your AWS credits, contact AWS support and request additional AWS credits. **No homework delay excuses will be accepted due to not having enough AWS credits** https://cmu.zoom.us/j/92130931602?pwd=ZDZiWUROUnlkQWhIcHNmRVZDcjZqQT09
- Submit first assignment by **Thursday 11:59pm ET/8:59pm PT**
- Bring your laptop with you next lecture! We will conduct our first lab on the cloud
- Install Docker on your machine https://www.docker.com/products/docker-desktop