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Introduction to Virtualization

Objectives

After completing this lesson, you should be able to:

- Define virtualization
- Describe virtualization concepts
- Explain why virtualization is relevant and useful
- Explain how virtualization helps companies save costs

What Is Virtualization?

- Virtualization refers to the process of creating a virtual version of something instead of its actual physical component.
- In computing, virtualization applies to:
  – Hardware components
  – CPU or processors
  – Storage
  – Network interfaces that constitute a virtual machine
- The virtual operating system platform has its own user applications.

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- Virtualization allows you to have multiple virtual operating systems running at the same time, as part of one physical machine.
- In computing, virtualization generates what is known as "virtual machines."
- Each virtual machine runs on its assigned virtual platform, and involve virtual hardware:
  - Virtual CPU, also known as a virtual processor, is a physical CPU that is assigned to a virtual machine.
  - Virtual Storage is the pooling of physical storage from multiple sources into what appears to be a single storage source.
  - Virtual Network – The two most common virtual networks are the following: 1) the one that connects virtual machines inside a hypervisor, and 2) protocol-based virtual networks, such as VLANs (Virtual LANs), VPNs (Virtual Private Networks) and VPLSs (Virtual Private LAN Services).
- All virtual machines run independently from one another—each with their own operating system and set of applications.

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What Does Virtualization Look Like?

Virtualization is composed of:

- One physical machine
  - Hardware (CPU, memory, hard drive, and so on)
- Hypervisor (Xen)
  - Virtual hardware
  - Software (OS, Apps)

VMs

- VM1, VM2, VM…

VMs share a set of resources available on the physical machine hosting those VMs.

VM2   VM2   VM3

Apps	Apps	Apps
OS	OS	OS
Virtual Hardware	Virtual Hardware	Virtual Hardware

Hypervisor – (Xen)

Hardware – (CPU, Memory, Disk)
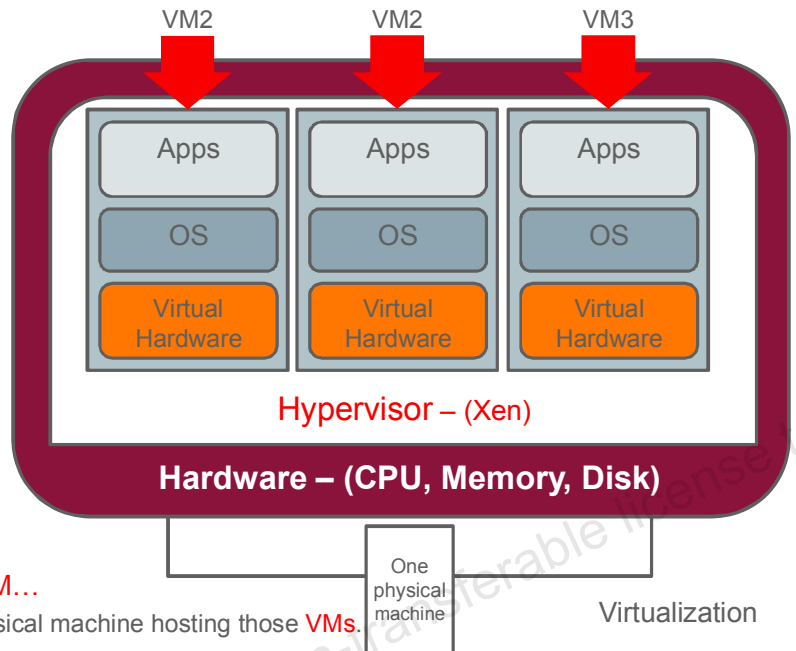
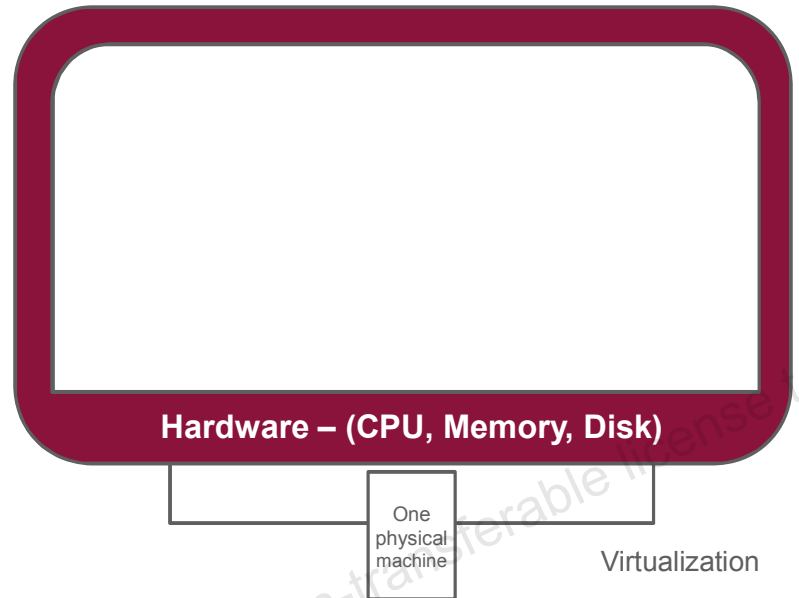One physical machine

Virtualization

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The diagram in the slide illustrates virtualization.

Major components in virtualization include:

- One physical machine that contains the necessary hardware resources
  - CPU, memory, network, hard drives, and so on
- Then, through the hypervisor, a virtual version of each hardware component is created.
  - Virtual CPU, virtual memory, virtual network, virtual hard drives, and so on
- The hypervisor is what allows for virtual machines to run their own operating system and applications.

Physical Components

- One physical machine
  - Server
  - PC
- Hardware (CPU, Memory, Disk, Network, and so on)

Hardware – (CPU, Memory, Disk)

One physical machine

Virtualization

- One machine can house multiple independent operating systems.
- All virtual machines share the same physical hardware.

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Software Component: Hypervisor

- Hypervisor creates a virtual platform on the host computer, on top of which multiple guest operating systems are executed and monitored.
- These guest operating systems run based on virtual hardware configured by the hypervisor.
- Applications are then executed within its operating system.
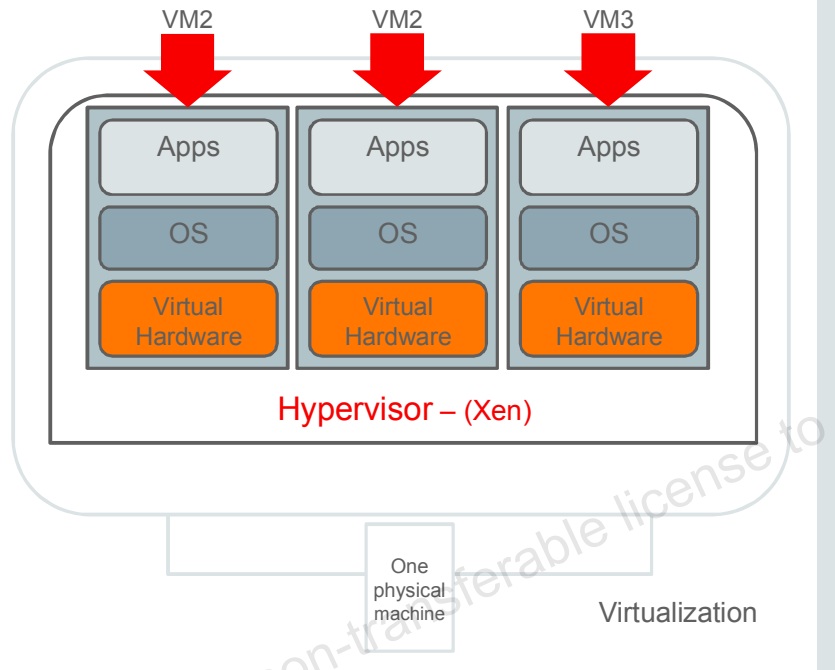
- Hypervisor
    - Is also called Virtual Machine Monitor (VMM)
    - Creates virtual platforms for (guest) operating systems
    - Controls access to the hardware resources
- Virtual Hardware
    - The hypervisor also provides virtual hardware to meet requirements for each individual operating system.
- Operating System
    - As mentioned earlier, the hypervisor creates and assigns virtual hardware components to each virtual machine. When the user is looking at the hardware information, the guest OS shows what was assigned by the hypervisor (virtual hardware components)—but the guest OS displays them as if they were its native, actual, hardware components.
- Apps
    - Applications are executed and run within their own environment.

Does the Host Machine Need an OS to Run a Hypervisor?

- Type 1: Native or Bare Metal Hypervisor
    - Software that runs directly on the host's hardware.
    - It monitors the guest operating systems.
    - The guest operating system runs on a separate level above the hypervisor.
- Type 2: Hosted Hypervisor
    - Designed to run on top of an existing operating system.
    - Adds a distinct software layer on top of the host operating system.
    - The guest operating system becomes the third software level above the hardware.

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Xen Technology

- Xen hypervisor
  - Type 1 bare metal hypervisor
  - Small and lightweight
  - Multiple virtual machines in one host computer
  - Each VM with its own OS

- The Xen hypervisor was originally created by researchers at Cambridge University and derived from work done at the Linux Kernel.
- The Xen hypervisor is a small and lightweight bare metal hypervisor for x86x-compatible computers. It securely executes multiple virtual machines in one host computer.
- Each VM has its own OS with almost native performance.
- The guest operating system runs on a level above the hypervisor.

Why Use Virtualization?

- Most common reason is to reduce cost.
- Other reasons include:
    - Resource optimization
    - Consolidation
    - Maximizing uptime
    - Easily migrating workload as business needs change
    - Protecting investment in existing legacy systems

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There are many benefits to virtualization, including saving money, reducing carbon footprint, using computing power more effectively, performing computing tasks more efficiently, and being able to manage, administer, and migrate systems more easily.

Subsequent slides in this lesson describe the benefits of virtualization in more detail.

How Does Virtualization Help in **Resource Optimization**?

- Today's enterprise computer resources are very powerful.
  - Virtualize hardware, and allocate hardware based on needs of users and applications.
  - There is no need to buy additional hardware. Consider creating virtual machines on your existing hardware with unused or underutilized resources.
- Software development environments
  - Each virtual machine is independent and can be isolated from all others.
  - Developers can run and test their applications in a sandbox type of environment on virtual machines without having to worry about product systems or applications.
- Result: Optimized use of your IT resources

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Resource Optimization

- Because today's enterprise-level computer resources are so powerful, you can use virtualization to get more out of your one single system.
- Virtualization allows you to use the host computer better, because you now have multiple virtual machines (guests) benefiting from the physical resources (CPU, memory, storage, and so on).
- Virtual machines offer software developers isolated, constrained, test environments.
  - All virtual machines run independently, so it's easy to test and run software applications.

How Does Virtualization Help in **Consolidation**?

- Reduces the number of physical machines in your data center by consolidating them into one and applying virtualization
  - Reduced costs
  - Environment friendly: less heat and power consumption, smaller carbon footprint
- Result: Reduced costs and more environment friendly

Consolidation

- If several applications use a small amount of processing power, many computers can be consolidated into one server running multiple virtual environments.
- For organizations that own hundreds or thousands of servers, consolidation can dramatically reduce physical space, A/C power, and other data center resources.
- Virtualization is also environment friendly, because consolidation results in using fewer resources and less space, which reduces carbon footprint.

How Does Virtualization Help to **Maximize Uptime**?

- Agility:
  - Spin up virtual machines quickly
- Data centers can offer users:
  - Guaranteed uptime of servers and applications
  - Instant deployment of new virtual machines
  - Elasticity, which means resource provisioning when and where required instead of keeping the entire data center in an "always-on" state
  - Reconfiguration of running computing environments without impacting the users
- Result: More efficient and enhanced user experience

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Maximizing Uptime

Some other benefits include:

- Speedy disaster recovery if large scale failures do occur
- Aggregated pools of virtual machines via template images

How Does Virtualization Help to **Easily Migrate Workloads**?

- Migration
  - You can move a server environment from one place to another.
  - It is possible to move a virtual machine from one physical machine in the environment to another.
  - A server can be migrated between physical hosts with entirely different hardware configurations.
- Why migrate?
  - To improve reliability and availability
  - In case a virtual machine needs to scale beyond the physical capabilities of the current host and is in need of improved hardware
- Result: Ease of virtual migration

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Easy Migration of Workloads as Business Needs Change

- With most virtualization solutions, it is possible to move virtual machines, as well as migrate a server between physical hosts regardless of the difference of their hardware configurations.

- It is important to be able to migrate virtual machines from one physical unit to another. One of the main reasons is hardware improvement and reliability.

How Does Virtualization Help to **Protect Investment in Existing Legacy Systems**?

- What happens when hardware becomes obsolete?
  - Virtualization is an ideal solution.
  - Run a virtual machine on new hardware, while the legacy system itself still behaves as if it were running on the same legacy hardware.
  - Even its performance may benefit from the underlying hardware.
- Result: Ability to execute old software on new hardware

Protecting Investment in Existing Legacy Systems

- Server hardware eventually becomes obsolete, and switching from one system to another can be difficult.
- With VMs, you can continue running legacy systems. From an application perspective, nothing changes.
- This solution gives an organization the time to transition to new processes without worrying about hardware issues, particularly in situations where the manufacturer of the legacy hardware no longer exists or cannot fix broken equipment.

Quiz

Q

Virtualization is when virtual machines are created as part of one physical machine, and share the same hardware resources.

a. True

b. False

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Quiz

What does the hypervisor do?

a. Creates platforms for (guest) operating systems
b. Creates virtual machines
c. Provides virtual hardware
d. All of the above
e. None of the above

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Quiz

Q

All virtual machines must use the same (guest) operating system.

a. True

b. False

Quiz

Why should you use virtualization?
a. To take full advantage of today's enterprise computing resources
b. To consolidate physical machines
c. To reduce costs
d. All of the above
e. None of the above

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Quiz

Q

All virtual machines run independently, so it is easy to test and run software applications.

a. True
b. False

Summary

In this lesson, you should have learned how to:

- Define virtualization
- Describe virtualization concepts
- Explain why virtualization is relevant and useful
- Explain how virtualization helps companies save costs