What is Virtualization?

Virtualization is technology that you can use to create virtual representations of servers, storage, networks, and other physical machines. Virtual software mimics the functions of physical hardware to run multiple virtual machines simultaneously on a single physical machine.

Why is virtualization important?

By using virtualization, you can interact with any hardware resource with greater flexibility. Physical servers consume electricity, take up storage space, and need maintenance.

Virtualization example

Consider a company that needs servers for three functions:

1. Store business email securely
2. Run a customer-facing application
3. Run internal business applications

Each of these functions has different configuration requirements:

- The email application requires more storage capacity and a Windows operating system.
- The customer-facing application requires a Linux operating system and high processing power to handle large volumes of website traffic.
- The internal business application requires iOS and more internal memory (RAM).

To meet these requirements, the company sets up three different dedicated physical servers for each application. The company must make a high initial investment and perform ongoing maintenance and upgrades for one machine at a time. The company also cannot optimize its computing capacity. It pays 100% of the servers' maintenance costs but uses only a fraction of their storage and processing capacities.

Virtual machines and **hypervisors** are two important concepts in virtualization.

Virtual machine

A *virtual machine* is a software-defined computer that runs on a physical computer with a separate operating system and computing resources. The physical computer is called the *host machine* and virtual machines are *guest machines*. Multiple virtual machines can run on a single physical machine. Virtual machines are abstracted from the computer hardware by a hypervisor.

Hypervisor

The *hypervisor* is a software component that manages multiple virtual machines in a computer. It ensures that each virtual machine gets the allocated resources and does not interfere with the operation of other virtual machines. There are two types of hypervisors.

Type 1 hypervisor

A type 1 hypervisor, or **bare-metal** hypervisor, is a hypervisor program installed directly on the computer's hardware instead of the operating system. Therefore, type 1 hypervisors have better performance and are commonly used by enterprise applications.

Some popular Type – 1 vendors are VMware vSphere, LynxSecure, RTS Hypervisor, Oracle VM, Sun xVM Server, VirtualLogic VLX and Xen.

Type 2 hypervisor

Also known as a hosted hypervisor, the type 2 hypervisor is installed on an operating system. Type 2 hypervisors are suitable for end-user computing.

Examples: Oracle VM Virtual Box, VMware Workstation Pro, and Windows Virtual PC.

What are the benefits of virtualization?

Efficient resource use

Virtualization improves hardware resources used in your data center. For example, instead of running one server on one computer system, you can create a virtual server pool on the same computer system by using and returning servers to the pool as required. Having fewer underlying physical servers frees up space in your data center and saves money on electricity, generators, and cooling appliances.

Automated IT management

Now that physical computers are virtual, you can manage them by using software tools. Administrators create deployment and configuration programs to define virtual machine templates. You can duplicate your infrastructure repeatedly and consistently and avoid error-prone manual configurations.

Faster disaster recovery

When events such as natural disasters or cyberattacks negatively affect business operations, regaining access to IT infrastructure and replacing or fixing a physical server can take hours or

even days. By contrast, the process takes minutes with virtualized environments. This prompt response significantly improves resiliency and facilitates business continuity so that operations can continue as scheduled.

What are the different types of virtualization?

You can use virtualization technology to get the functions of many different types of physical infrastructure and all the benefits of a virtualized environment. You can go beyond virtual machines to create a collection of virtual resources in your virtual environment.

Server virtualization

Server virtualization is a process that partitions a physical server into multiple virtual servers. It is an efficient and cost-effective way to use server resources and deploy IT services in an organization. Without server virtualization, physical servers use only a small amount of their processing capacities, which leave devices idle.

Storage virtualization

Storage virtualization combines the functions of physical storage devices such as network attached storage (NAS) and storage area network (SAN). You can pool the storage hardware in your data center, even if it is from different vendors or of different types. Storage virtualization uses all your physical data storage and creates a large unit of virtual storage that you can assign and control by using management software. IT administrators can streamline storage activities, such as archiving, backup, and recovery, because they can combine multiple network storage devices virtually into a single storage device.

Network virtualization

Any computer network has hardware elements such as switches, routers, and firewalls. An organization with offices in multiple geographic locations can have several different network technologies working together to create its enterprise network. Network virtualization is a process that combines all of these network resources to centralize administrative tasks. Administrators can adjust and control these elements virtually without touching the physical components, which greatly simplifies network management.

The following are two approaches to network virtualization.

Software-defined networking

Software-defined networking (SDN) controls traffic routing by taking over routing management from data routing in the physical environment. For example, you can program your system to prioritize your video call traffic over application traffic to ensure consistent call quality in all online meetings.

Network function virtualization

Network function virtualization technology combines the functions of network appliances, such as firewalls, load balancers, and traffic analyzers that work together, to improve network performance.

Data virtualization

Modern organizations collect data from several sources and store it in different formats. They might also store data in different places, such as in a cloud infrastructure and an on-premises data center. Data virtualization creates a software layer between this data and the applications that need it. Data virtualization tools process an application's data request and return results in a suitable format. Thus, organizations use data virtualization solutions to increase flexibility for data integration and support cross-functional data analysis.

Application virtualization

Application virtualization pulls out the functions of applications to run on operating systems other than the operating systems for which they were designed. For example, users can run a Microsoft Windows application on a Linux machine without changing the machine configuration. To achieve application virtualization, follow these practices:

- **Application streaming** – Users stream the application from a remote server, so it runs only on the end user's device when needed.
- **Server-based application virtualization** – Users can access the remote application from their browser or client interface without installing it.
- **Local application virtualization** – The application code is shipped with its own environment to run on all operating systems without changes.

Desktop virtualization

Most organizations have nontechnical staff that use desktop operating systems to run common business applications. For instance, you might have the following staff:

- A customer service team that requires a desktop computer with Windows 10 and customer-relationship management software
- A marketing team that requires Windows Vista for sales applications

You can use desktop virtualization to run these different desktop operating systems on virtual machines, which your teams can access remotely. This type of virtualization makes desktop management efficient and secure, saving money on desktop hardware. The following are types of desktop virtualization.

Virtual desktop infrastructure

Virtual desktop infrastructure runs virtual desktops on a remote server. Your users can access them by using client devices.

Local desktop virtualization

In local desktop virtualization, you run the hypervisor on a local computer and create a virtual computer with a different operating system. You can switch between your local and virtual environment in the same way you can switch between applications.

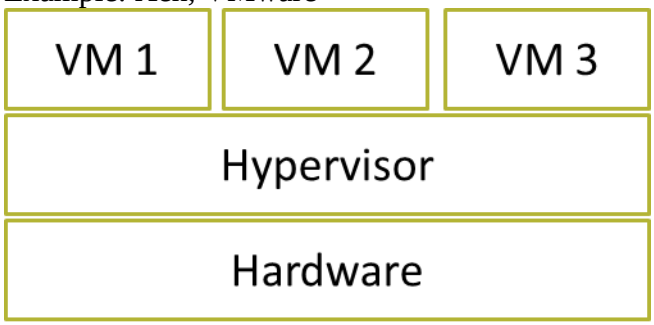
How is virtualization different from cloud computing?

Cloud computing is the on-demand delivery of computing resources over the internet with pay-as-you-go pricing. Instead of buying, owning, and maintaining a physical data center, you can access technology services, such as computing power, storage, and databases, as you need them from a cloud provider.

Virtualization technology makes cloud computing possible. Cloud providers set up and maintain their own data centers. They create different virtual environments that use the underlying hardware resources. You can then program your system to access these cloud resources by using APIs. Your infrastructure needs can be met as a fully managed service.

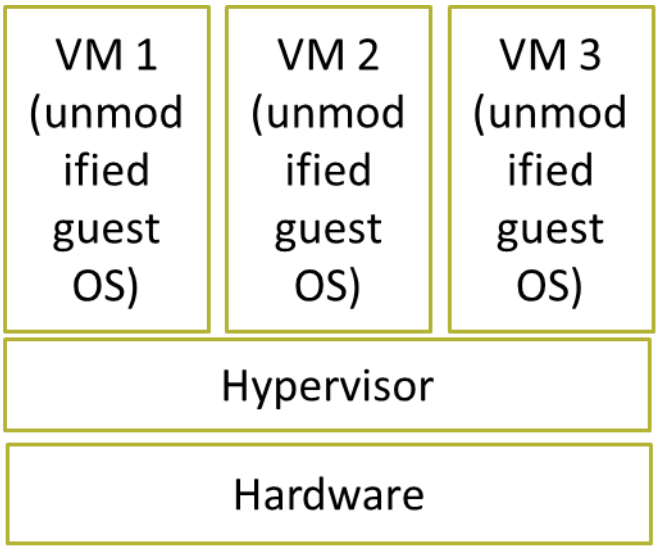
Virtualization Structures\ Hardware Virtualization

- We know that the *virtualization layer* transforms the physical hardware into virtual hardware. There are three classes of VM architectures.
    - **Hypervisor Architecture:**
        - It is the hardware level virtualization. Also called the bare-metal virtualization
        - The hypervisor sits between the hardware and the VMs and manages the VMs.
        - Example: Xen, VMware



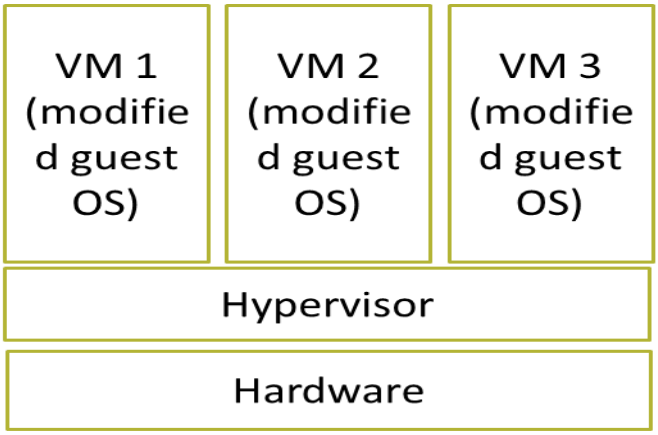
- Native Virtualization Architecture:

- **Full-virtualization Architecture:**
  - The guest operating system (OS) or the VM's OS does not know that it is installed on a VM.
  - The Virtualization layer manages the hardware acceleration. For example VMware
  - The virtualization layer can be installed on hardware or on host's OS.
  - Some of the instructions of a guest VM are directly run on hardware to enhance the performance.



- Full Virtualization:

- **Para-virtualization Architecture:**
  - The guest OS is modified to comply with virtualization layer. All calls for hardware acceleration are handled by virtualization layer.
  - For example: KVM



Para Virtualization: