



# Other Types of Virtualization & Virtualization and Cloud Computing

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# Application-level Virtualization

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- Allowing applications to be run in runtime environments ***that do not natively support*** all the features required by such applications.
- Applications ***are not installed*** in the expected runtime environment ***but are run as though they were.***
  - Partial file systems
  - Libraries
  - Operating system component emulation.

# Application-level Virtualization

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- Emulation is performed by a thin layer
  - A program or an operating system component which is in charge of executing the application.
  
- Emulation can also be used to execute program binaries compiled for different hardware architectures.
  
- A popular application virtualization solution: Wine
  - Allowing Unix-like operating systems to execute programs written for the Microsoft Windows platform.

# Application-level Virtualization

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## ➤ Wine acts as a container for the guest application

- A set of libraries, called Winelib

“Wine (originally an acronym for "Wine Is Not an Emulator") is a compatibility layer capable of running Windows applications on several POSIX-compliant operating systems, such as Linux, macOS, & BSD. Instead of simulating internal Windows logic like a virtual machine or emulator, Wine translates Windows API calls into POSIX calls on-the-fly, eliminating the performance and memory penalties of other methods and allowing you to cleanly integrate Windows applications into your desktop.”

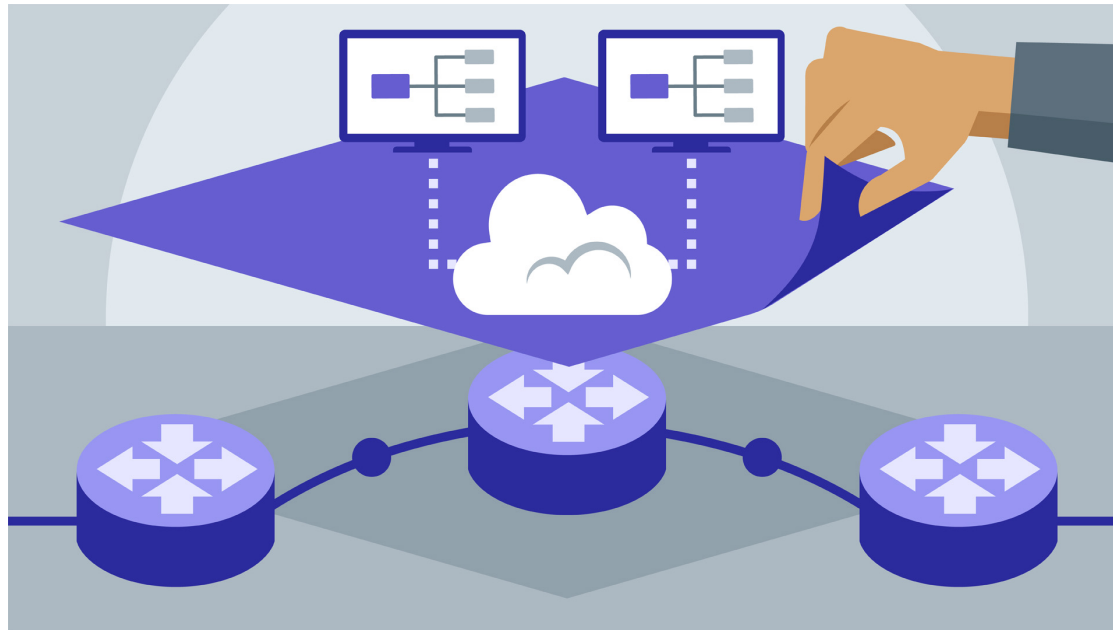
<https://www.winehq.org/>

## ➤ A similar solution for the Mac OS X environment is CrossOver

- Allows running Windows applications directly on the Mac OS X.

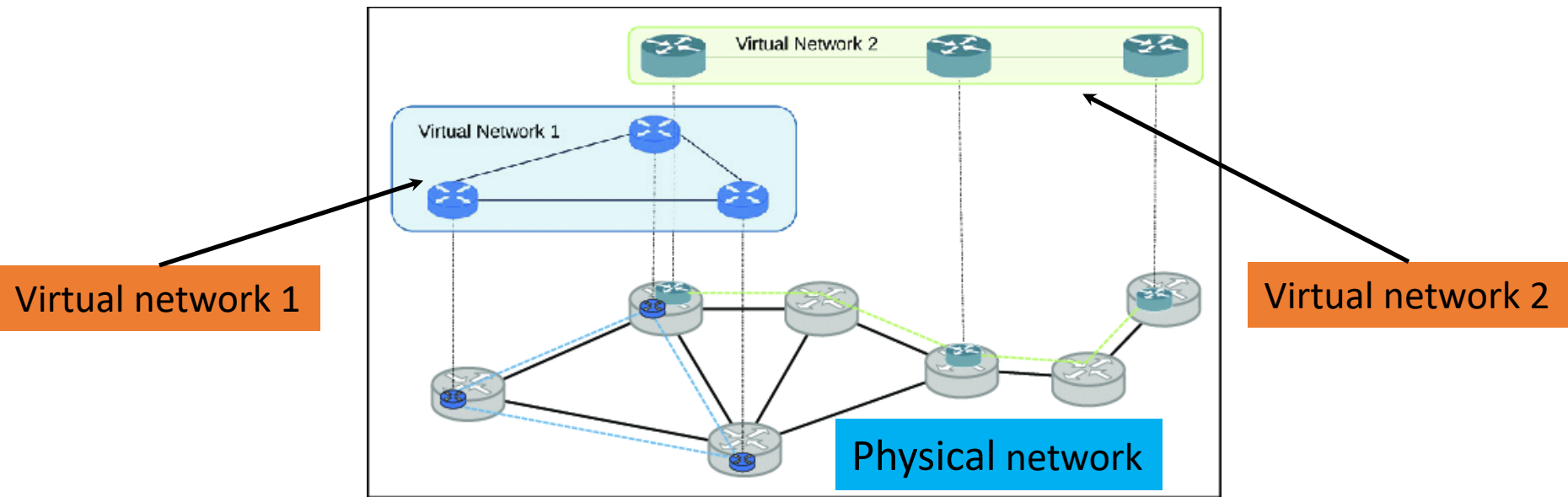
# Network Virtualization

- ***Segment the physical network resources*** in cloud data centers into smaller segmentations and lease it to cloud tenants
  - Like leasing VMs in clouds enabled by host virtualization.



# Network Virtualization

- Multiple virtual networks (VNs) share a physical network and run ***isolated*** protocol stacks.
- Network virtualization allows users to design and deploy a network ***without requiring knowledge of the physical network***.



# Storage Virtualization

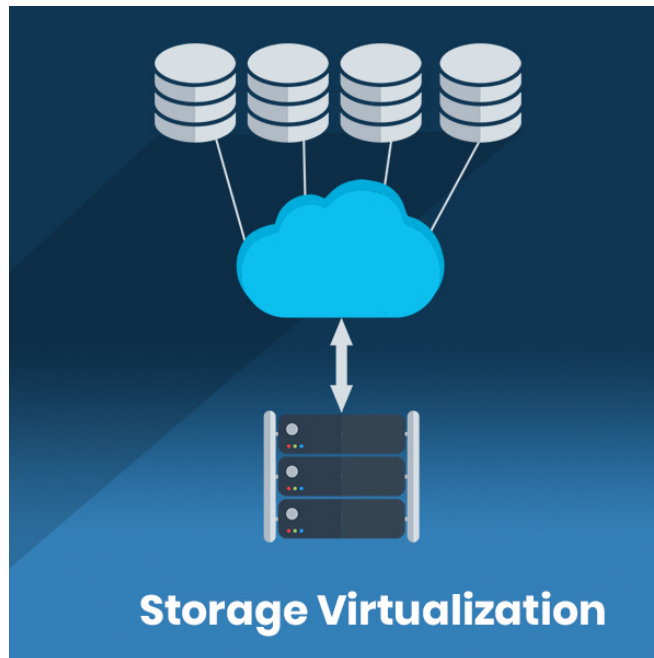
- A system administration practice that allows ***decoupling the physical organization of the hardware from its logical representation.***
- Users do not have to be worried about the specific location of their data, which can be identified using a logical path.



# Storage Virtualization (cont.)

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- **Grouping** multiple (possibly heterogeneous) storage devices that are seen as a single virtual storage space.



<https://www.veritis.com/solutions/virtualization/storage-virtualization-services/>



# Storage Virtualization (cont.)

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➤ Two main abstractions to represent storage virtualization:

- **Virtual volumes**

- Simplifies the task of assigning disks to VMs.

- **Virtual data objects**

- Enables scalable and redundant creation and retrieval of data objects directly into/from the cloud.

➤ The details of which disks and partitions contain which objects or volumes are transparent to users

- Facilitates storage management for cloud providers.

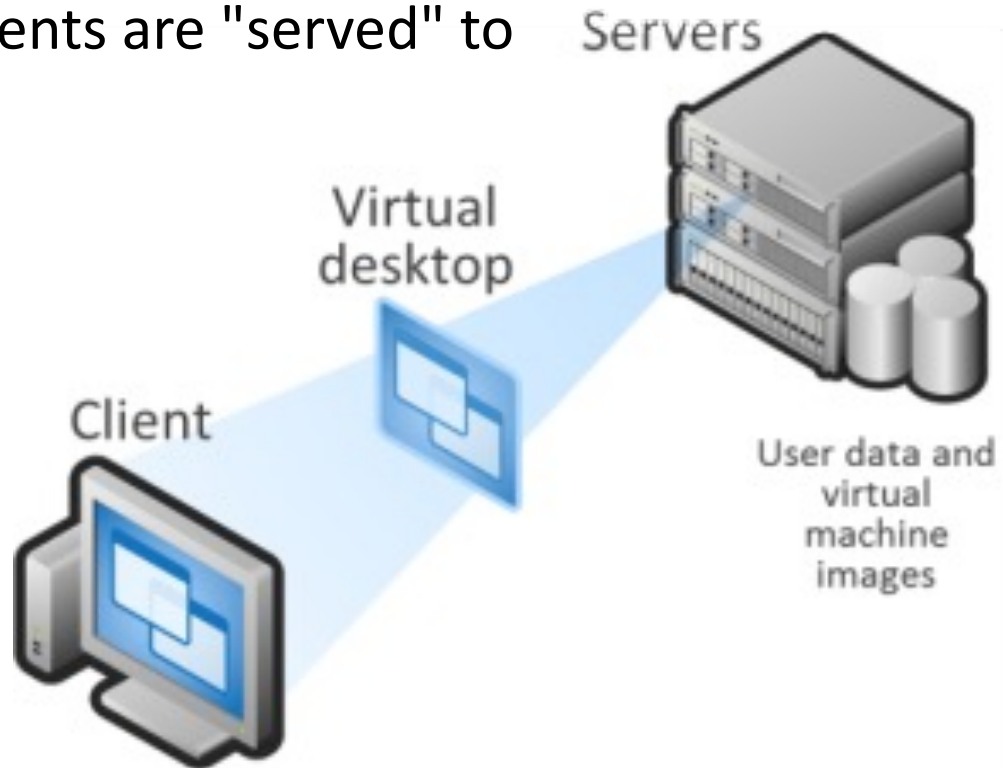
# Desktop Virtualization (cont.)

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- ***Abstracts the desktop environment*** available on a personal computer in order to provide access to it using a client/server approach.
- Makes accessible a different system as though it were natively installed on ***the host***
  - but this system is remotely stored on ***a different host*** and accessed through a ***network connection***.

# Desktop Virtualization (cont.)

"virtualizes desktop computers and these virtual desktop environments are "served" to users on the network."



**Making the same desktop environment accessible from everywhere.**

<http://omicro.net/desktop-virtualization/>

# Desktop Virtualization (cont.)

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- Hardware virtualization is fundamental to provide access to multiple desktop environments hosted on the same server.
- A specific desktop environment is stored in a virtual machine image that is loaded and started on demand when a client connects to the desktop environment.

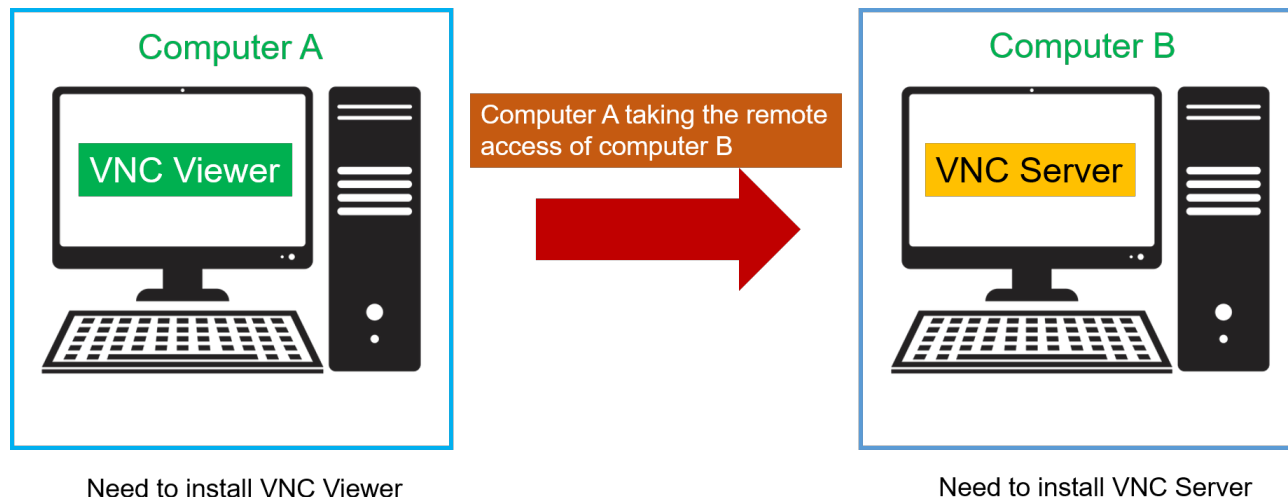
# Desktop Virtualization-Examples

## ➤ Windows Remote Service



## ➤ Virtual Network Computing (VNC)

- Graphical desktop-sharing system to remotely control another computer.



<https://linuxapt.com/blog/install-and-configure-vnc-on-ubuntu-20-04>

# Virtualization and Cloud Computing

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- Virtualization **plays an important role in cloud computing**
  - It allows for the appropriate degree of **customization, security, isolation, and manageability** that are fundamental for delivering IT services on demand.
- Virtualization technologies are primarily used to offer configurable computing environments and storage.

# Virtualization and Cloud Computing (cont.)

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- **Hardware virtualization** is an enabling factor for ***IaaS*** (Infrastructure-as-a-Service)
- **Programming language virtualization** is leveraged in ***PaaS*** (Platform-as-a-Service).
- Virtualization gives the opportunity to design ***more efficient*** computing systems by means of **consolidation**
  - Which is performed transparently to cloud computing service users.

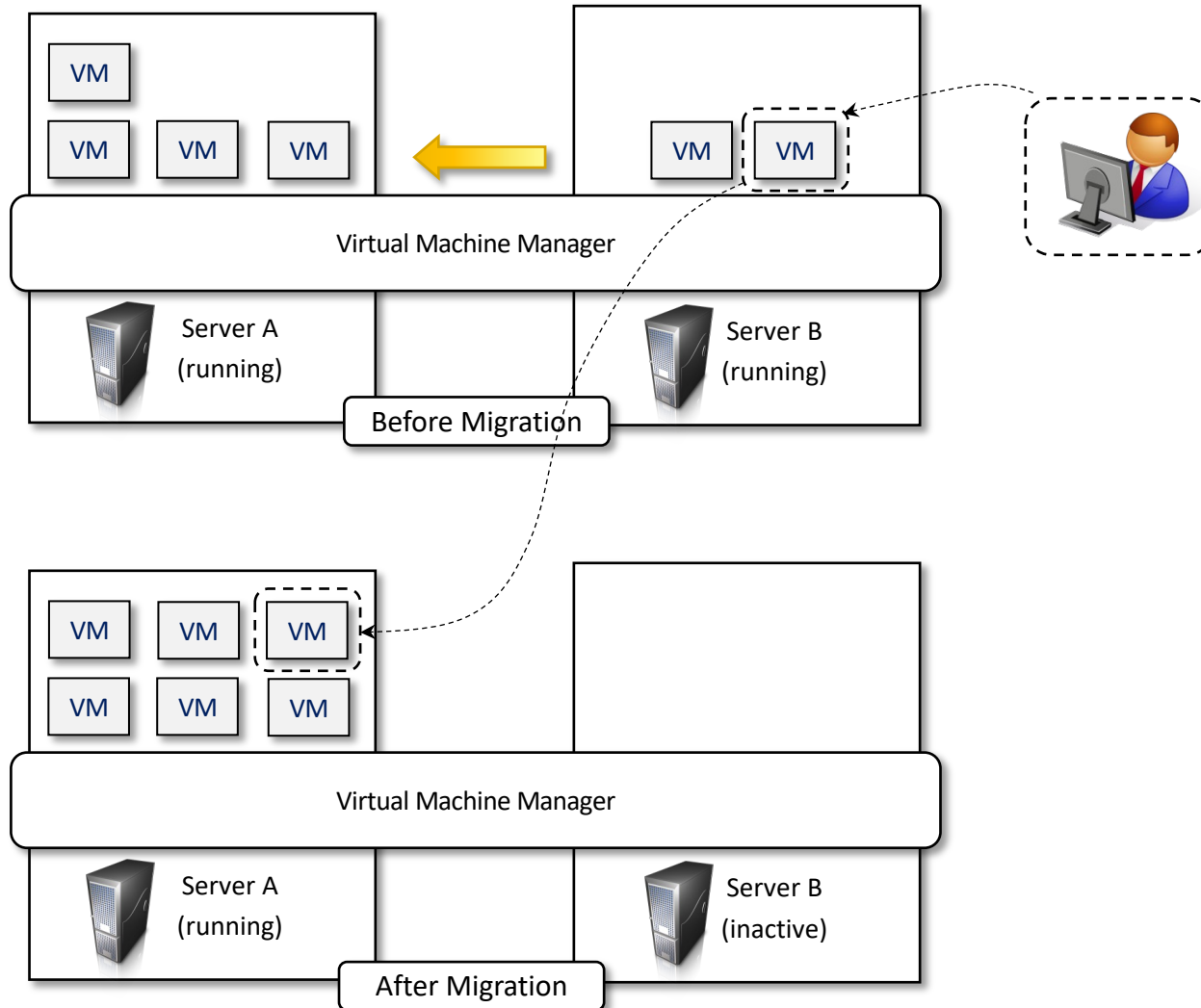
# Consolidation

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- When resources are *underutilized*, we can *reduce the number of active physical resources* by *aggregating* virtual machines over a smaller number of resources that become *fully utilized*
- Using **VM migration** (but when? how?)
  - Live migration: moving the instance while it is running which is more complex but more efficient.



# Consolidation (cont.)



# Virtualization Disadvantages

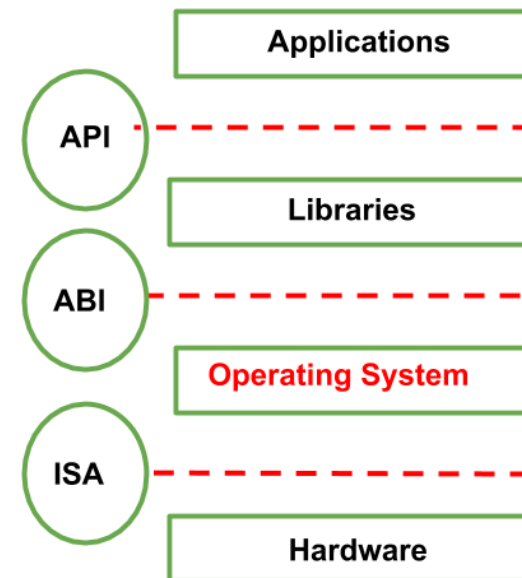
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- Performance degradation.
- Inefficiency and degraded user experience.
- Security holes and new threats.

# Performance degradation

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- One of the major concerns in using virtualization technology
- Since virtualization interposes an abstraction layer between the guest and the host, the guest can experience ***increased latencies***.



# Performance degradation-Root causes

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- In the case of hardware virtualization
- Overhead introduced by the following activities:
  - Maintaining the status of virtual processors
  - Support of privileged instructions
    - Trap and simulate privileged instructions
  - Support of paging within VM
  - ....

# Performance degradation-Type 2 hypervisor

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➤ The degradation *is more serious*

- Since hypervisor is installed on top of an operating system

➤ Similar consideration can be made in the case of virtualization technologies at higher levels

- In the case of programming language virtual machines
  - Java, .NET, and others
- Binary translation and interpretation *can slow down* the execution of managed applications.

# Inefficiency

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- Virtualization can sometime lead to an inefficient use of the host.
- In particular, some of the specific features of the host ***cannot be exposed by the abstraction layer and then become inaccessible.***
- In hardware virtualization, this could happen for ***device drivers***:
  - The virtual machine can sometime simply provide a default graphic card that maps only a subset of the features available in the host.

# Security holes and new threats

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- Virtualization opens the door to a new&unexpected form of **phishing**
  - The capability of emulating a host in a completely transparent manner led the way to malicious programs that are ***designed to extract sensitive information from the guest.***
  
- In the case of hardware virtualization, malicious programs can ***preload*** themselves before the operating system and ***act as a thin*** virtual machine manager toward it.
  - Examples: BluePill and SubVirt

# Security holes and new threats

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- The same considerations can be made for programming-level virtual machines.
  - ***Modified versions of the runtime environment can access sensitive information or monitor the memory locations*** utilized by guest applications while these are executed.