



# Other Types of Virtualization & Virtualization and Cloud Computing

Seyyed Ahmad Javadi

[sajavadi@aut.ac.ir](mailto:sajavadi@aut.ac.ir)

Spring 2023



# Application-level Virtualization

---

- 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 (cont.)

---

- 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 (cont.)

---

## ➤ 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.

# Application-level Virtualization (cont.)



**CrossOver® Mac**

Do you like buying Windows® licenses? You do? Great. You do you. For the rest of humanity, CrossOver is the easiest way to run many Microsoft applications on your Mac without a clunky Windows emulator. (Seriously, have you tried emulators? Do you like how they run on your Mac?) CrossOver works differently. It's not an emulator. It does the work of translating Windows commands into Mac commands so that you can run Windows software as if it were designed native to Mac.

CrossOver works with all kinds of software – productivity software, utility programs, and games – all with one application.

Faster. Better experience. No license. Simple as that.

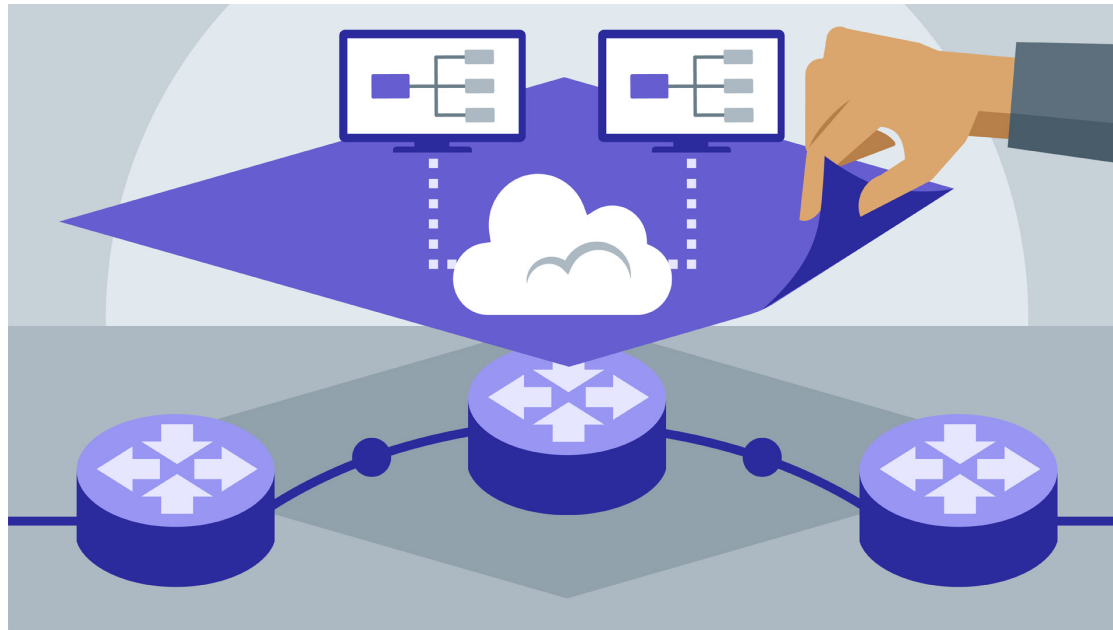
**BUY NOW – \$64.00 USD**      **FREE TRIAL**

<https://www.codeweavers.com/crossover>

<https://www.youtube.com/watch?v=FCmSHPd-OG4>

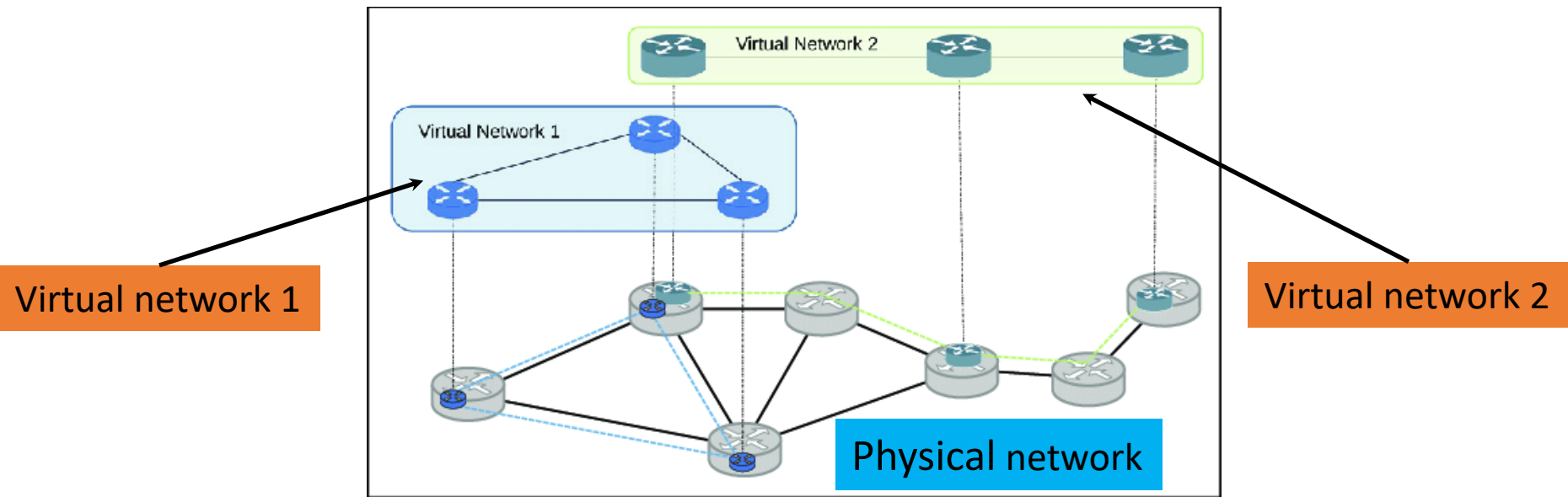
# Network Virtualization

- ***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

---

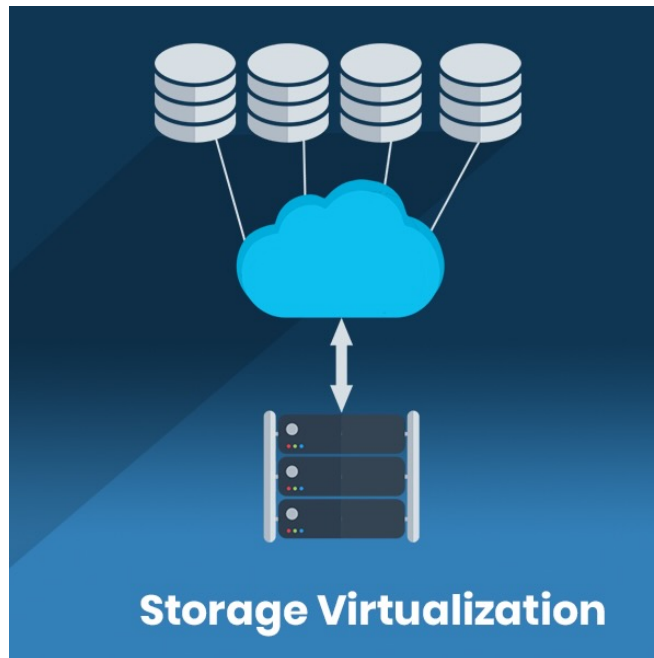
- A system administration practice that allows ***decoupling the physical organization of the hardware from its logical representation.***
- Users do not have to be worried about the specific location of their data, which can be identified using a logical path.





# Storage Virtualization (cont.)

- **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.)

---

➤ 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.

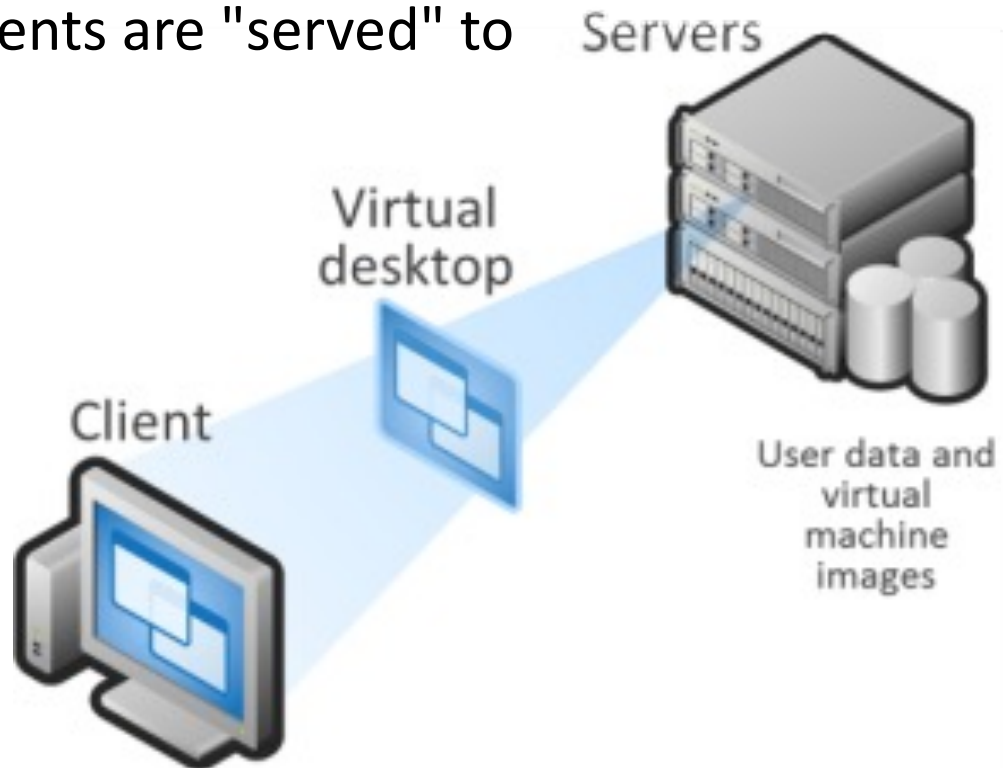
# Desktop Virtualization (cont.)

---

- ***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.)

---

- 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.

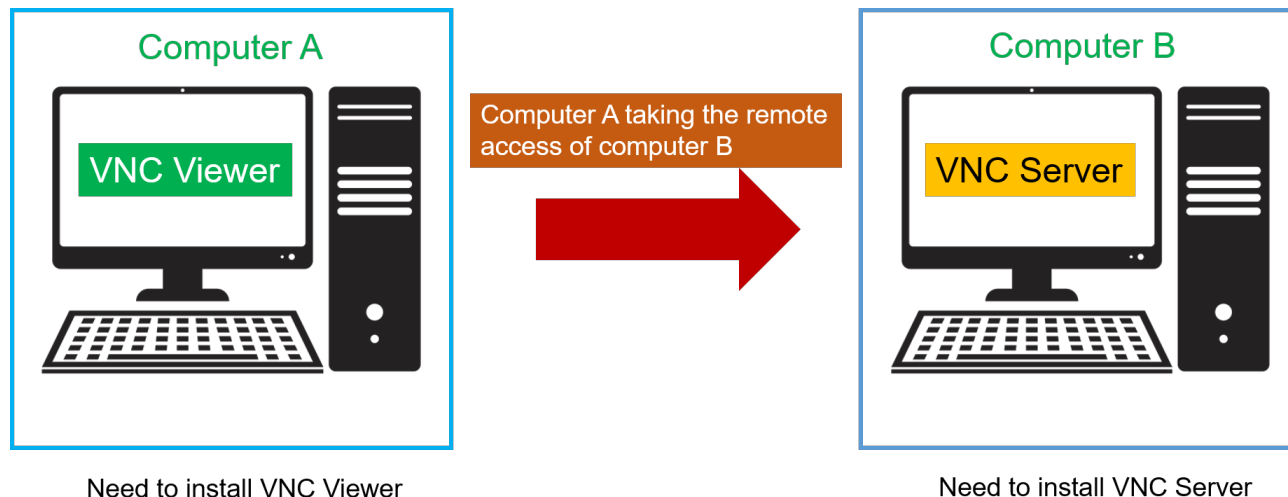
# Desktop Virtualization-Examples

## ➤ 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

---

- 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.)

---

- **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.

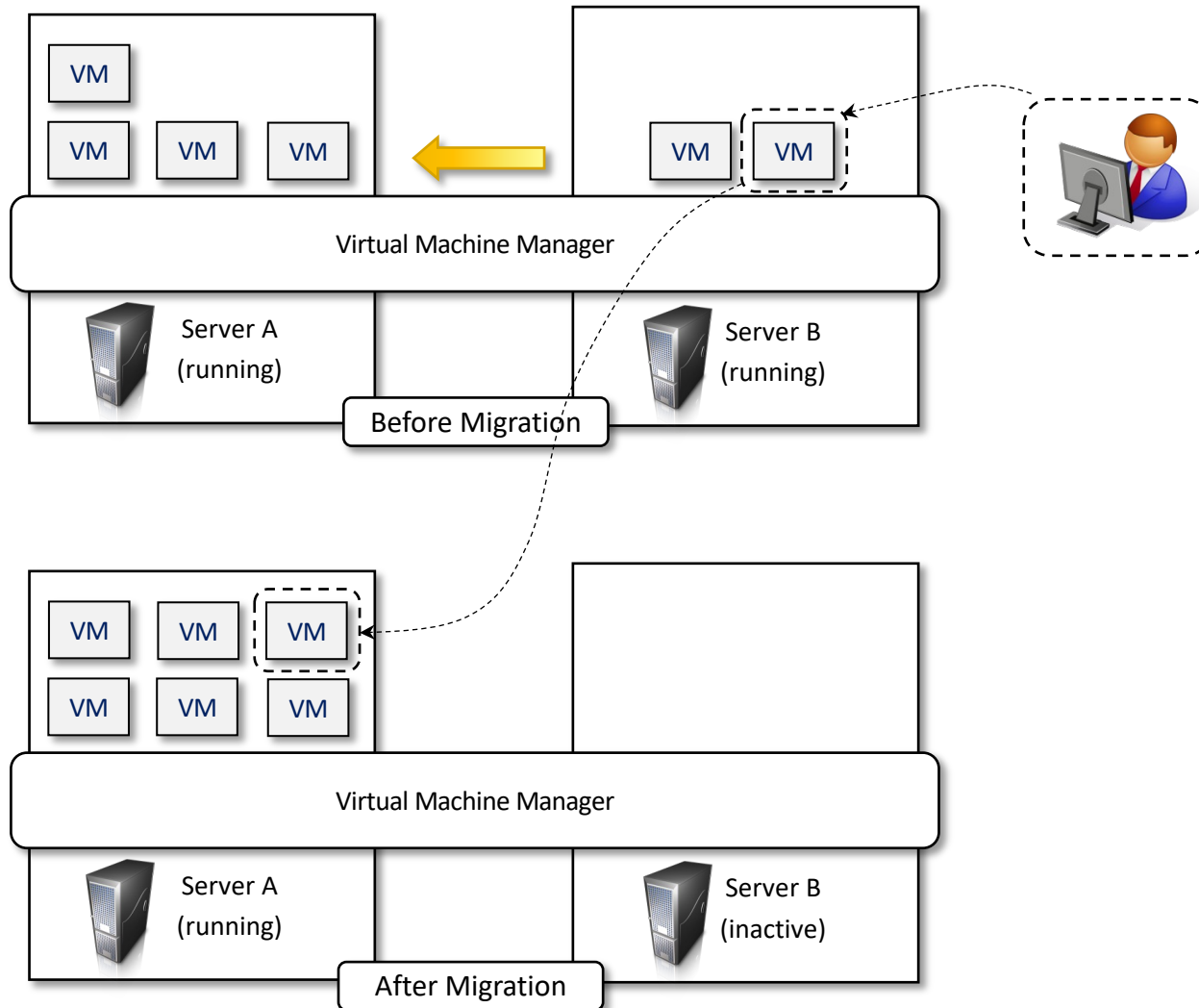


# Consolidation

---

- 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

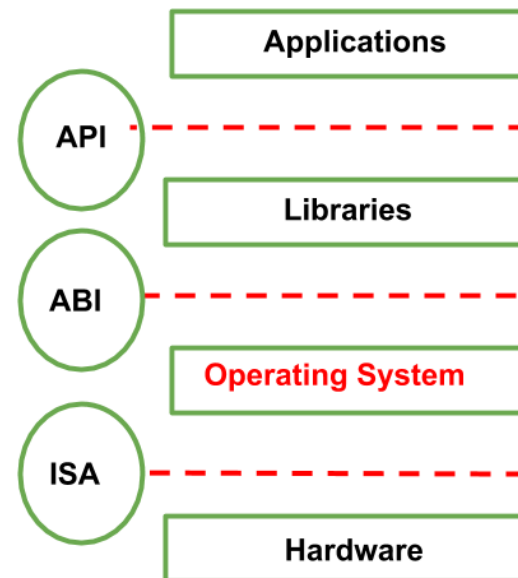
---

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

# Performance degradation

---

- 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

---

- 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

---

➤ 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

---

- 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

---

- 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

---

➤ 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.