Other Types of Virtualization & Virtualization and Cloud Computing

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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.)

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.
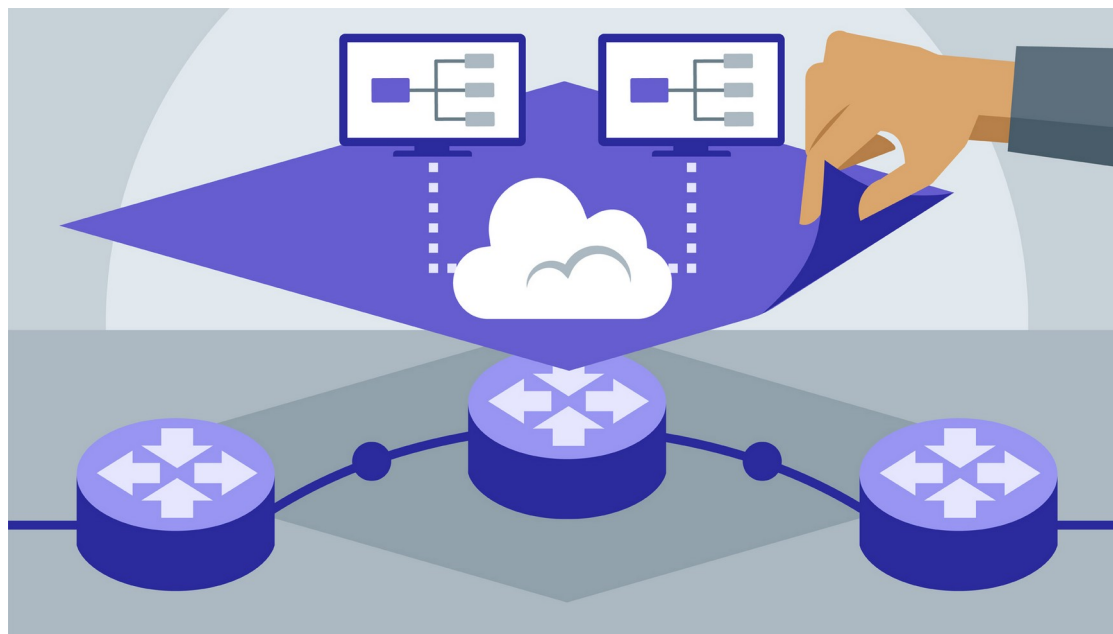
Network Virtualization

➢ 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*.
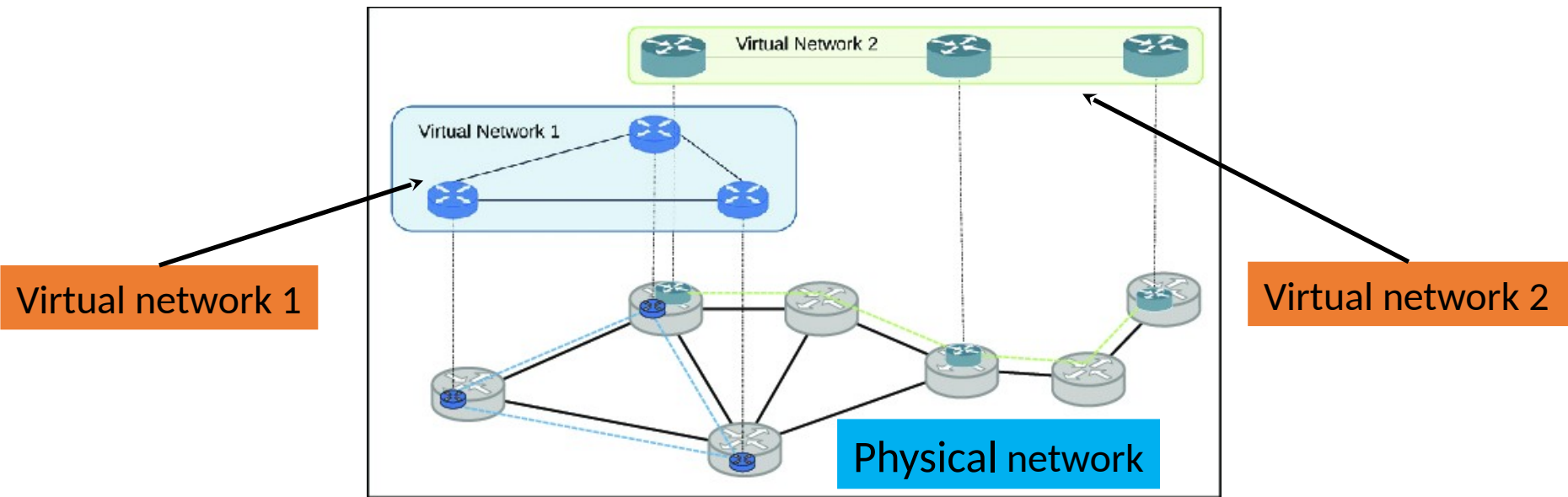
Storage Virtualization

➤ 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.
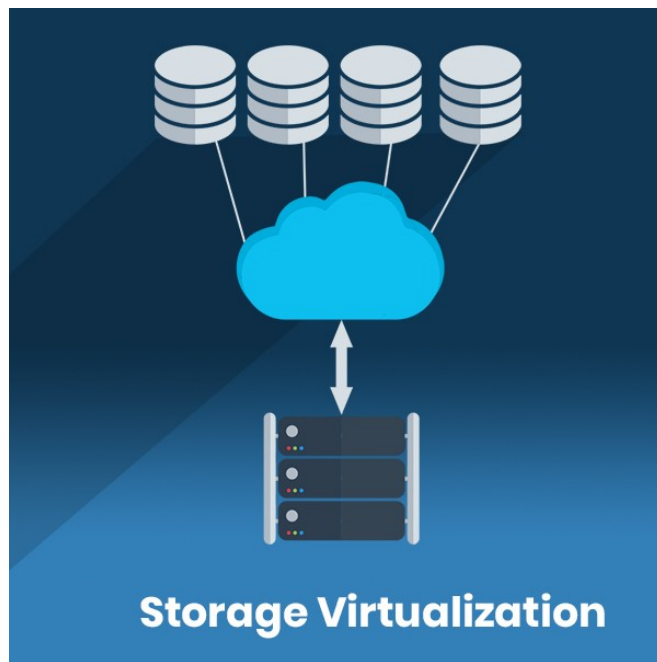

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Storage Virtualization (cont.)

➢ **Grouping** multiple (possibly heterogeneous) storage devices that

are seen as a single virtual storage space.

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.

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.)

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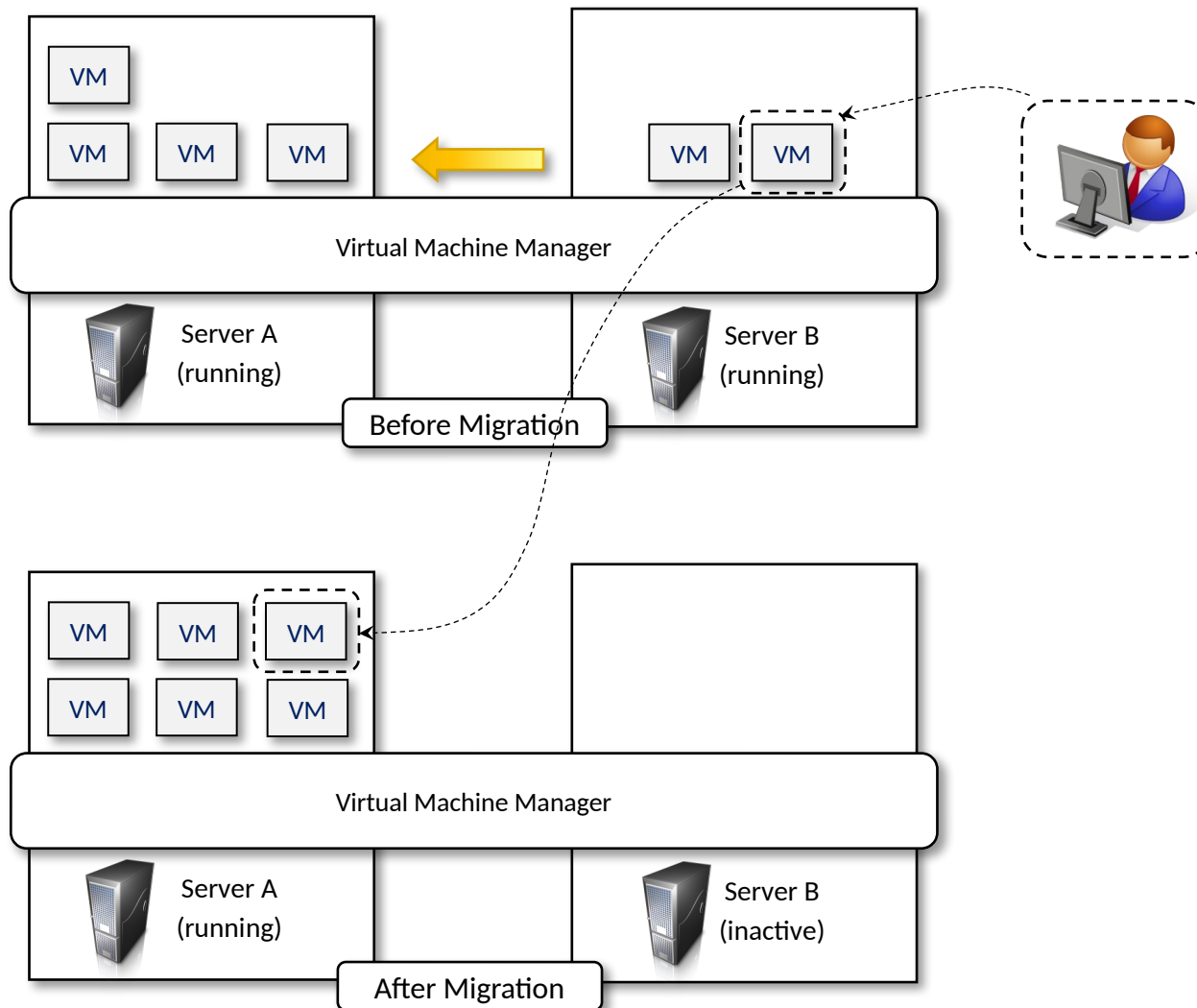
Virtualization Disadvantages

➤ 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***.
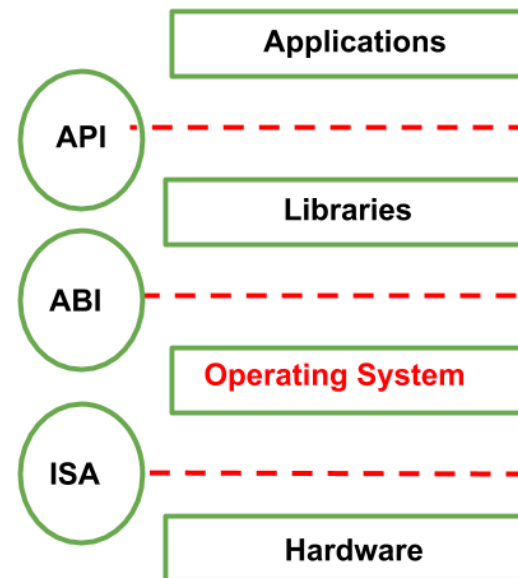
Performance degradation-Root causes

➤ 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.