VIRTUALIZATION

DEPARTMENT OF DATA SCIENCE AND COMPUTER APPLICATIONS,

MANIPAL INSTITUTE OF TECHNOLOGY,

MANIPAL ACADEMY OF HIGHER EDUCATION

INTRODUCTION

- Logical abstraction of computing resources
- i.e. separation of resource and/or service request from underlying physical delivery of that service request
- A means of separating hardware from a single operating system
- Allows multiple operating system instances to run concurrently on a single computer.

INTRODUCTION (CONTD..)

- Virtualization is a technique of how to separate a service from the underlying physical delivery of that service. It is the process of creating a virtual version of something like computer hardware.
- It was initially developed during the mainframe era.
- It involves using specialized software to create a virtual or software-created version of a computing resource rather than the actual version of the same resource.
- With the help of virtualization, multiple operating systems and applications can run on same machine and its same hardware at the same time, increasing the utilization and flexibility of hardware.

INTRODUCTION (CONTD..)

- In other words, one of the main cost effective, hardware reducing, and energy saving techniques used by cloud providers is virtualization.
- Virtualization allows to share a single physical instance of a resource or an application among multiple customers and organizations at one time.
- It does this by **assigning a logical name to a physical storage and providing a pointer to that physical resource** on demand.
- The term virtualization is often synonymous with hardware virtualization, which plays a fundamental role in efficiently delivering infrastructure-as-a-service (IaaS) solutions for cloud computing.
- Moreover, virtualization technologies provide a virtual environment for not only executing applications but also for storage, memory, and networking.

BENEFITS

- More flexible and efficient allocation of resources.
- Enhance development productivity.
- It lowers the cost of it infrastructure.
- Remote access and rapid scalibility.
- High availability and disaster recovery.
- Pay per use of the it infrastructure on demand.
- Enables running multiple operating system.

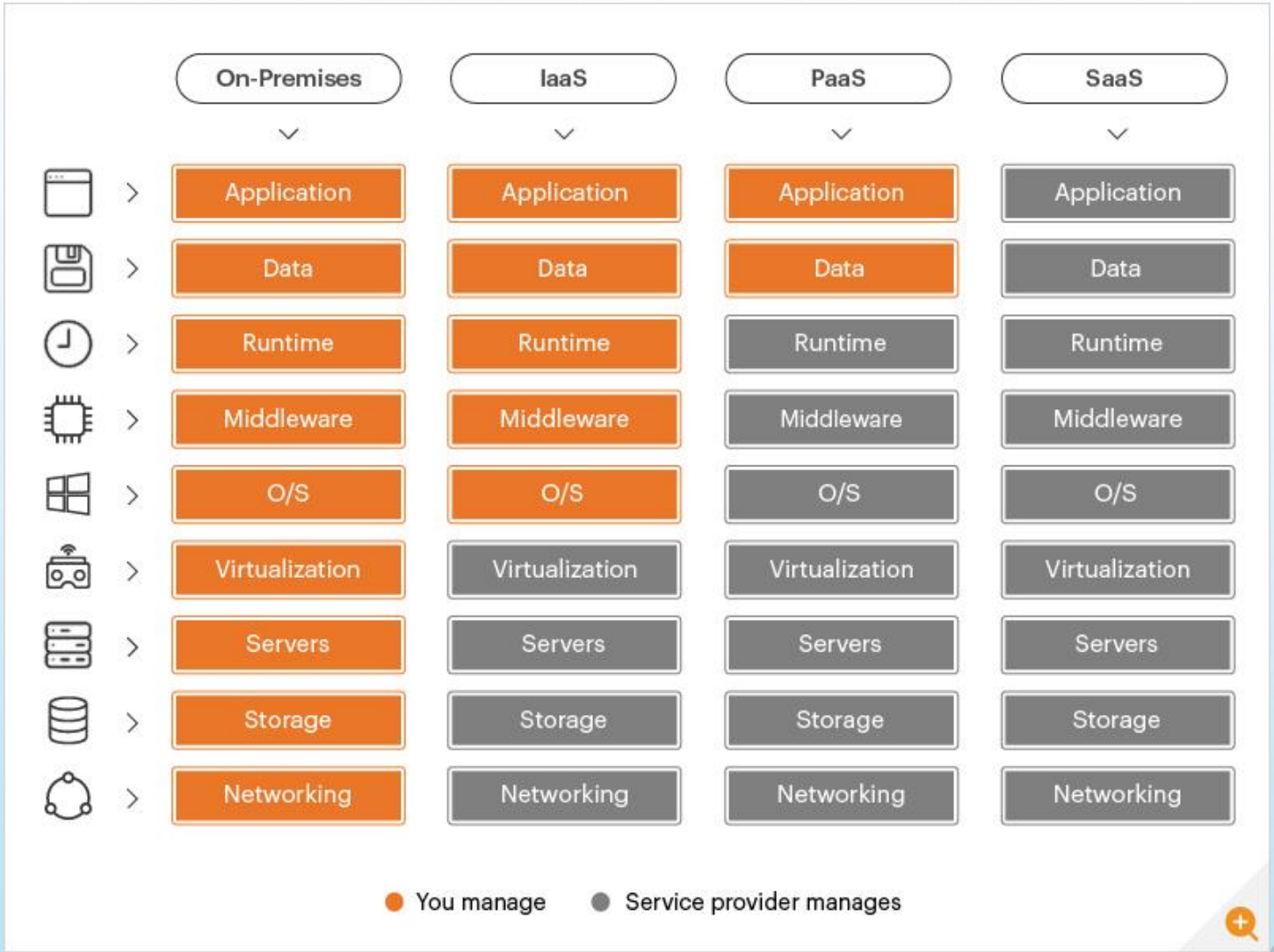
CONCEPT AND TYPES

- The machine on which the virtual machine is going to be created is known as **host machine** and that virtual machine is referred as a **guest machine**

Types of virtualization:

- Data virtualization
- Hardware virtualization.
- Application virtualization.
- Network virtualization.
- Desktop virtualization.
- Storage virtualization.
- Server virtualization.
- Operating system virtualization.

CONCEPT AND TYPES



CHARACTERISTICS

- **Increased Security**
- **Managed Execution**
- **Sharing**
- **Aggregation**
- **Emulation**
- **Isolation**
- **Portability**

CHARACTERISTICS (CONTD..)

Increased Security

- The ability to control the execution of guest programs in a completely transparent manner opens new possibilities for delivering a secure, controlled execution environment.
- All the operations of the guest programs are generally performed against the virtual machine, which then translates and applies them to the host programs.
- A virtual machine manager can control and filter the activity of the guest programs, thus preventing some harmful operations from being performed.
- Resources exposed by the host can then be hidden or simply protected from the guest.
- Increased security is a requirement when dealing with untrusted code.

CHARACTERISTICS (CONTD..)

Example

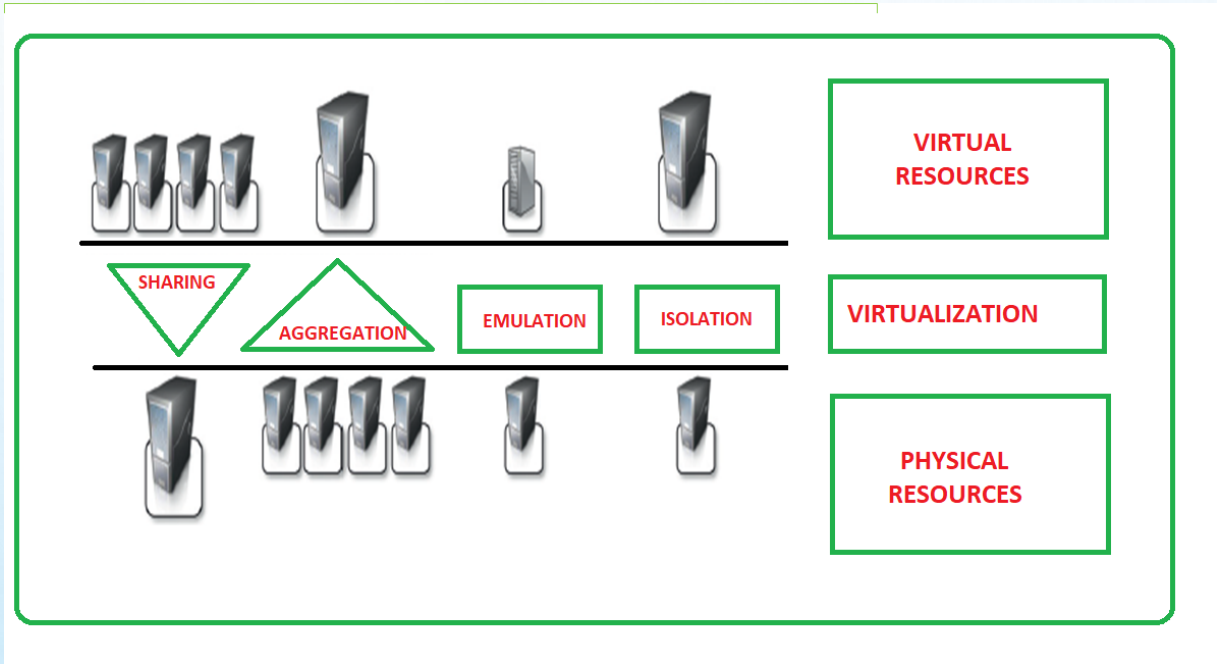
- **Example-1:** untrusted code can be analyzed in cuckoo sandbox environment. The term sandbox identifies an isolated execution environment where instructions can be filtered and blocked before being translated and executed in the real execution environment.

- **Example-2:** the expression sandboxed version of the java virtual machine (JVM) refers to a particular configuration of the JVM where, by means of security policy, instructions that are considered potentially harmful can be blocked.

CHARACTERISTICS (CONTD..)

Managed Execution

- In particular, sharing, aggregation, emulation, and isolation are the most relevant features.



CHARACTERISTICS (CONTD..)

Sharing

- Virtualization allows the creation of a separate computing environments within the same host.
- This basic feature is used to reduce the number of active servers and limit power consumption.

Aggregation

- Not only possible to share physical resources among several guests, but virtualization also allows aggregation, which is the opposite process.
- A group of separate hosts can be tied together and represented to guests as a single virtual host.
- This functionality is implemented with cluster management software, which harnesses the physical resources of a homogeneous group of machines and represents them as a single resource.

CHARACTERISTICS (CONTD..)

Emulation

- Guest programs are executed within an environment that is controlled by the virtualization layer, which ultimately is a program.
- Also a completely different environment with respect to the host can be emulated, thus allowing the execution of guest programs requiring specific characteristics that are not present in the physical host.

Isolation

- Virtualization allows providing guests—whether they are operating systems, applications, or other entities—with a completely separate environment, in which they are executed.
- The guest program performs its activity by interacting with an abstraction layer, which provides access to the underlying resources.
- The virtual machine can filter the activity of the guest and prevent harmful operations against the host.

CHARACTERISTICS (CONTD..)

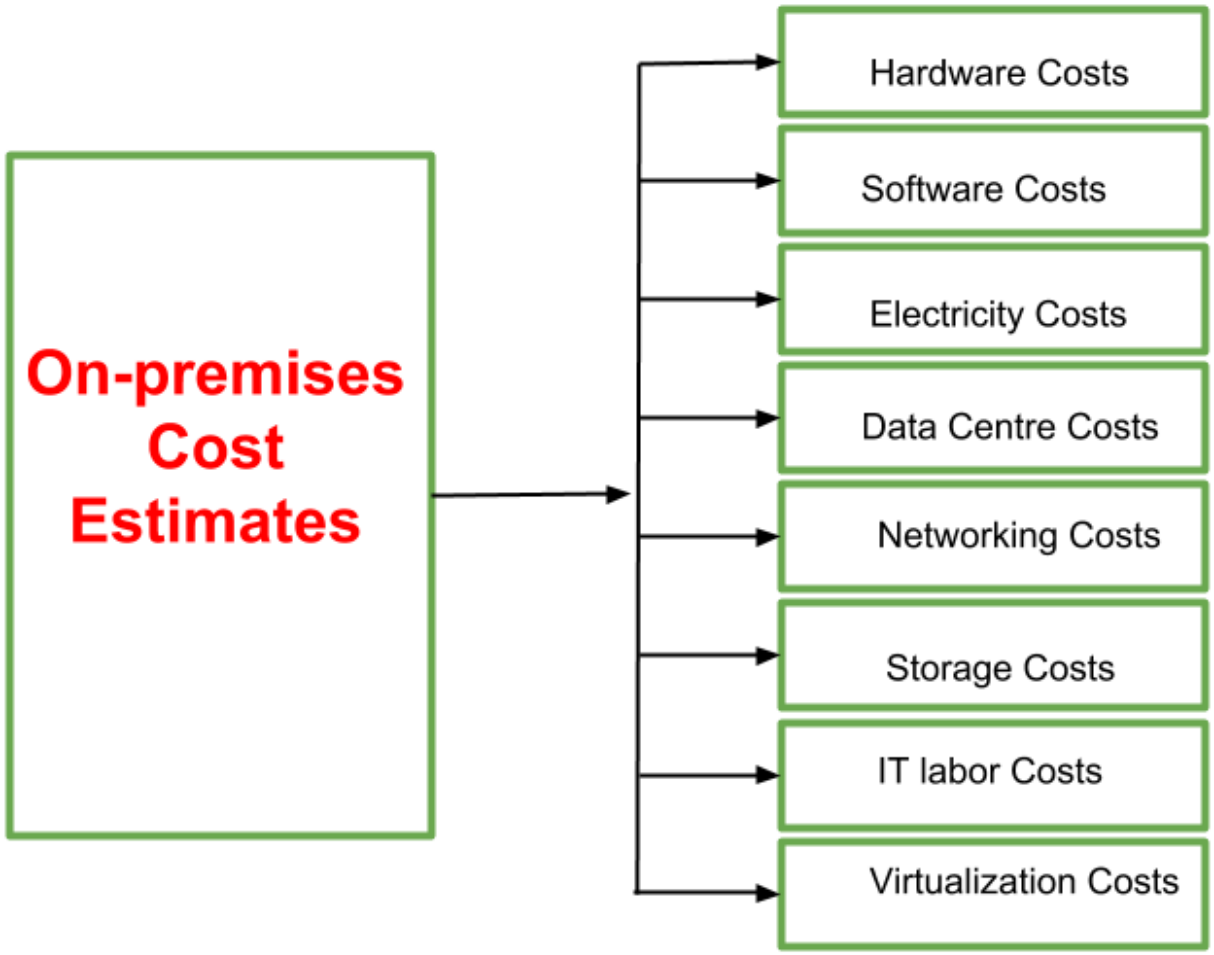
Portability

- The concept of portability applies in different ways according to the specific type of virtualization considered.
- In the case of a hardware virtualization solution, the guest is packaged into a virtual image that, in most cases, can be safely moved and executed on top of different virtual machines.
- In the case of programming-level virtualization, as implemented by the JVM or the .Net runtime, the binary code representing application components (jars or assemblies) can run without any recompilation on any implementation of the corresponding virtual machine

HYPERVISOR

- A program that allows multiple operating systems to share a single hardware host.
- Also called virtual machine manager/monitor (vmm), or virtualization manager.
- Hypervisor actually controls processor and resources, allocating what is needed to each operating system in turn and making sure that the guest operating systems (vms) don't disrupt each other.
- Virtual machine: a self-contained computing environment that behaves as if it is a separate computer.

COST ESTIMATION



COST ESTIMATION (CONTD..)

HARDWARE COSTS

- Based on the user's description, the calculator uses estimated market rates to project the costs of requisite physical hardware.

SOFTWARE COSTS

- If the user specifies an operating system for the environment, then the calculator provides an estimate of the OS licensing costs based on the number of cores required by the user's environment.

ELECTRICITY COSTS

- Estimates the approximate electricity consumption costs. This is done by allocating a power rating to the user's hardware configuration and then multiplying it with an estimate of the power consumed and an industry-standard rate for power consumption.

COST ESTIMATION (CONTD..)

DATA CENTER COSTS

- Based on the user's description, the calculator estimates the requisite amount of normalized rack space.

NETWORKING COSTS

- Networking hardware and software costs are estimated to be a fixed percentage of the on-premises hardware and software costs. The calculator also adds a service provider cost based on the outbound bandwidth requirements specified by the user.

STORAGE COSTS

- The calculator computes storage cost by multiplying an estimated market rate the amount of disk space specified by the user.

COST ESTIMATION (CONTD..)

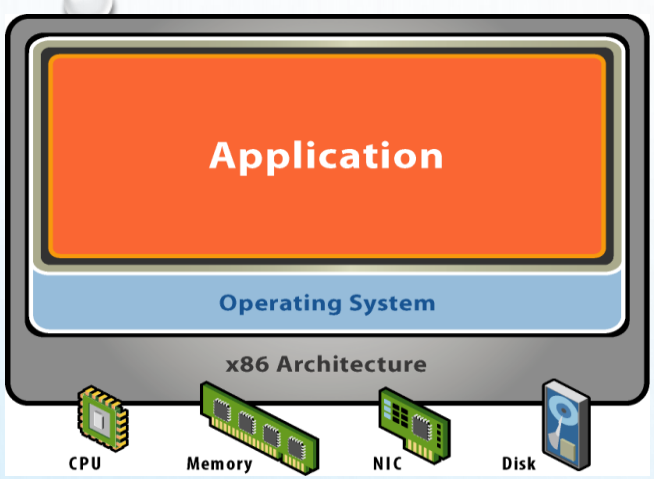
IT LABOR COSTS

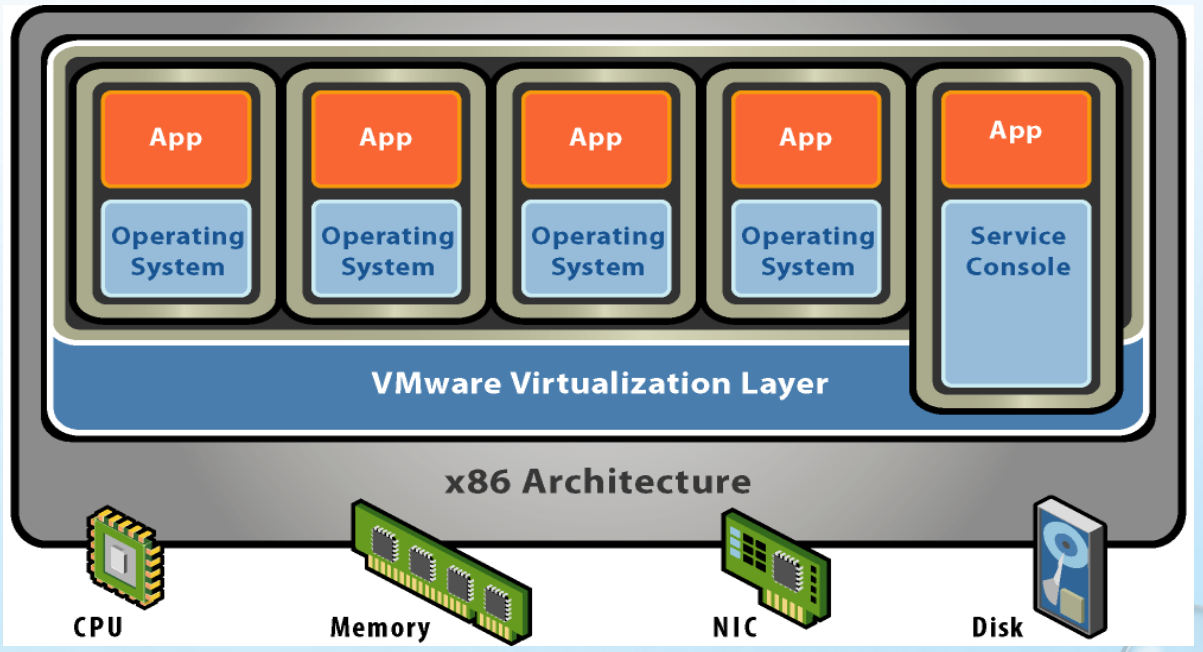
- Based on the user's description, the calculator estimates the number of IT administrator man-hours that will be required to maintain the on-premises environment.

VIRTUALIZATION COSTS

- If the user's description includes virtual machines, the calculator uses an industry standard per virtual machine management rate to estimate the total virtualization costs.

ARCHITECTURE DIFFERENCES





DIFFERENCES

BEFORE VIRTUALIZATION:

- Single OS image per machine
- Software and hardware tightly coupled
- Running multiple applications on same machine often creates conflict
- Underutilized resources
- Inflexible and costly infrastructure.

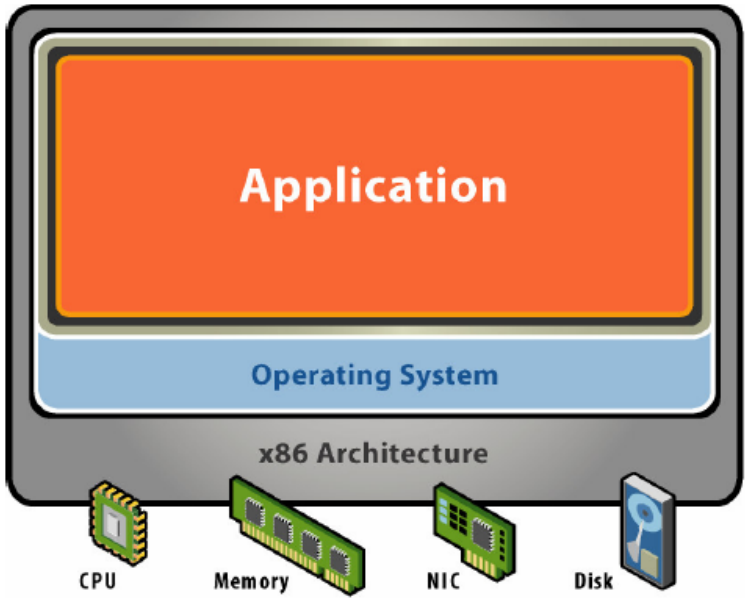
AFTER VIRTUALIZATION:

- Hardware-independence of operating system and applications
- Virtual machines can be provisioned to any system
- Can manage OS and application as a single unit by encapsulating them into virtual machines

DIFFERENCES

- **TRADITIONAL COMPUTING ARCHITECTURE HAS :**
  - Hardware
  - Operating system
  - Application program(s)
- **VIRTUALIZATION ARCHITECTURE HAS :**
  - Hardware (centralized / decentralized)
  - Virtualization layer (VMM)
  - Host operating system
  - Application program(s) //VM
  - Hosted (guest) operating system(s)
  - Hosted (guest) application program(s)

Starting Point: A Physical Machine



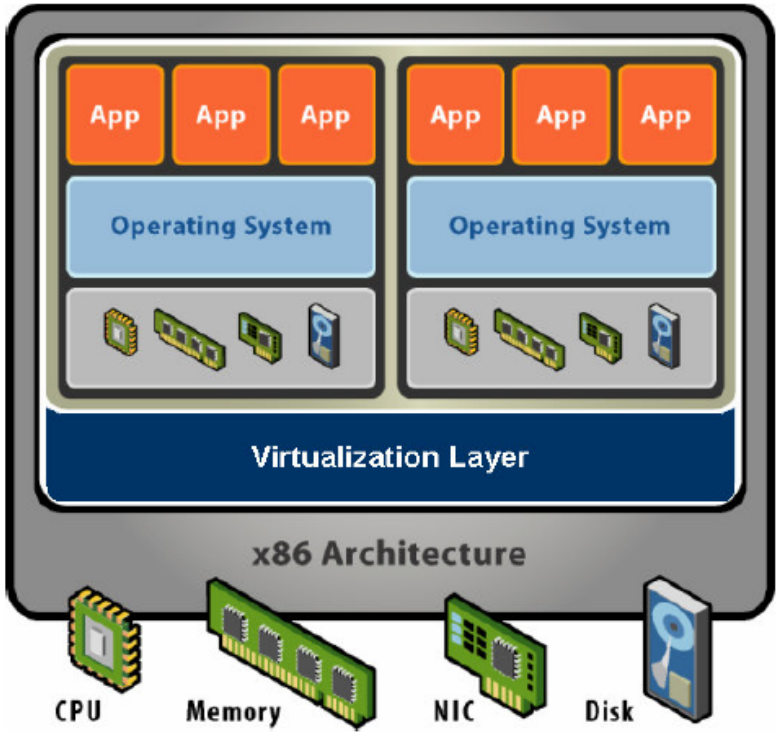
Physical Hardware

- Processors, memory, chipset, I/O bus and devices, etc.
- Physical resources often underutilized

Software

- Tightly coupled to hardware
- Single active OS image
- OS controls hardware

What is a Virtual Machine?



Hardware-Level Abstraction

- Virtual hardware: processors, memory, chipset, I/O devices, etc.
- Encapsulates all OS and application state

Virtualization Software

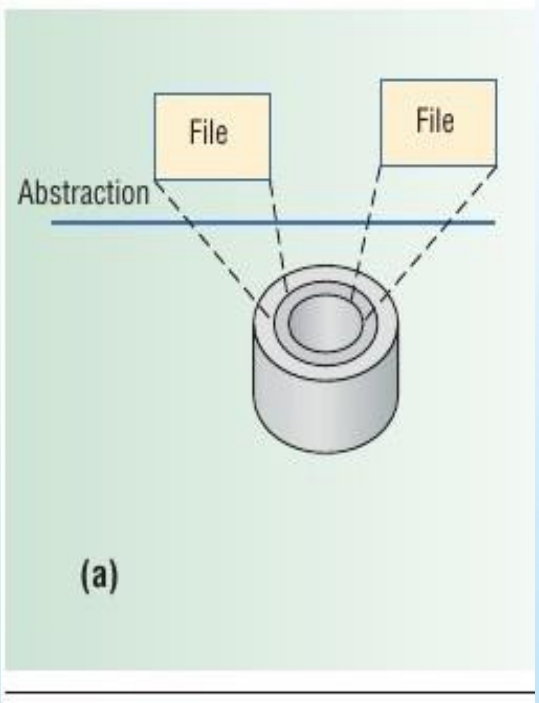
- Extra level of indirection decouples hardware and OS
- Multiplexes physical hardware across multiple “guest” VMs
- Strong isolation between VMs
- Manages physical resources, improves utilization

ARCHITECTURE OF VIRTUAL MACHINES

- VM can support individual processes or a complete system
- Virtualization can be from OS to programming languages to processor architecture.
- VMs enhance
  - Software interoperability (to work together)
  - System impregnability (having strength)
  - Platform versatility

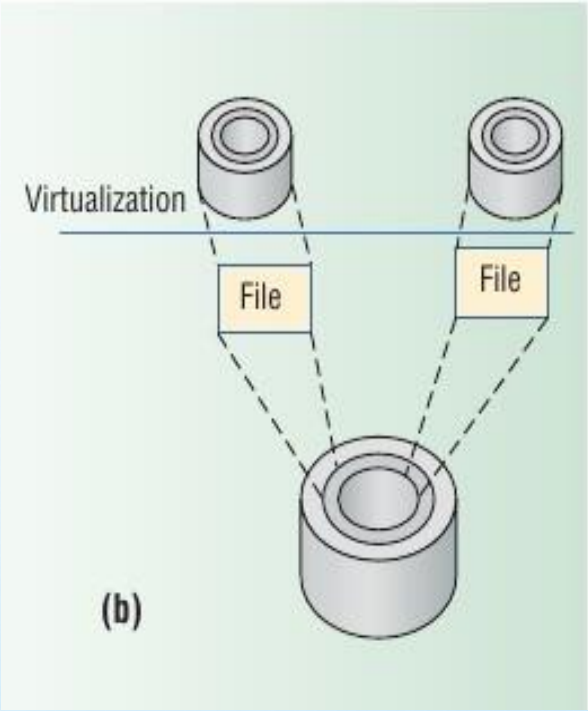
ABSTRACTION AND VIRTUALIZATION

- Computer system is complex, and yet it continue to evolve.
- Computer is designed as hierarchies of well- defined interfaces that separate level of abstraction
- Simplifying abstractions hide lower-level implementation details
- Abstraction
  - Ex. Disk storage
  - Hides hard-disk addressing details (sectors and tracks)
  - It appears to application software as a variable sized files.
  - User can create, write and read files without knowing the underneath details.



VIRTUALIZATION

- Virtualization of system or components like – processor, memory or an I/O device – at a given abstraction level.
- It transforms a entire system or components of the system

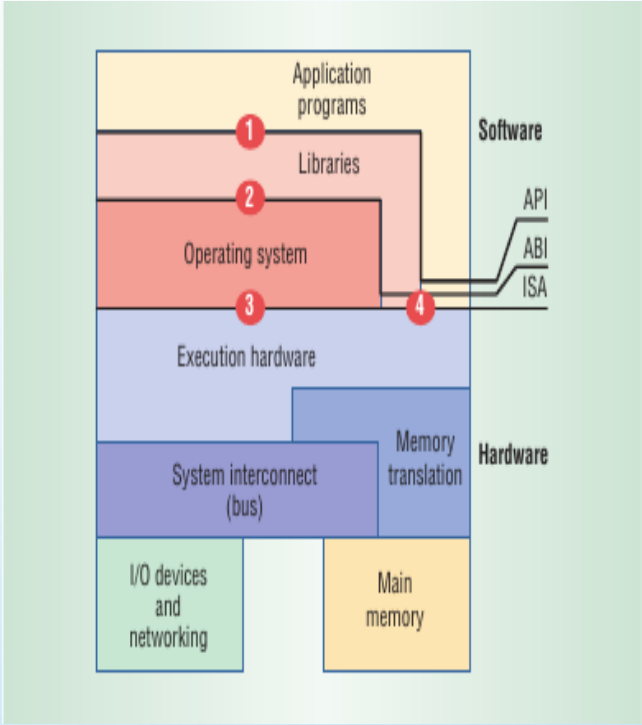


ARCHITECTED INTERFACES

- Architecture, as applied to computer systems, refer to a formal specification to an interface in the system, including the logical behavior of the resources managed via the interface.
- Implementation describes the actual embodiment of an architecture.
- Abstraction levels correspond to implementation layers, having its own interface or architecture.

COMPUTER SYSTEM ARCHITECTURE

- Interfaces at or near the H/w S/w boundary
- ISA – instruction set architecture.
- API – application program interface
- ABI – application binary interface



VIRTUALIZED ENVIRONMENTS

- Three major components of virtualized environments
- **Guest –** system component that interacts with virtualization layer.
- **Host –** original environment where guest runs.
- **Virtualization layer –** recreate the same or different environment where guest will run.

VIRTUALIZATION REFERENCE MODEL