Virtualization is a technique, which allows to share single physical instance of an application or resource among multiple organizations or customers. It does so by assigning a logical name to a physical resource and providing a pointer to that physical resource on demand. Virtualization Concept Creating a virtual machine over existing operating system and hardware is referred as Hardware Virtualization. Virtual Machines provide an environment that is logically separated from the underlying hardware. The machine on which the virtual machine is created is known as host machine and virtual machine is referred as a guest machine.
Moreover, virtualization technologies provide a virtual environment for not only executing applications but also for storage, memory, and networking.

Virtualization technologies have gained renewed interested recently due to the of several phenomena:

- Increased performance and computing capacity. Nowadays, the average end-user desktop PC is powerful enough to meet almost all the needs of everyday computing, with extra capacity that is rarely used. Almost all these PCs have resources enough to host a virtual machine manager and execute a virtual machine with by far acceptable performance.
- Underutilized hardware and software resources. Hardware and software underutilization is occurring due to (1) increased performance and computing capacity, and (2) the effect of limited use of resources. Computers today are so powerful that in most cases only a fraction of their capacity is used by an application or the system. Moreover, if we consider the IT infrastructure of an enterprise, many computers are only partially utilized whereas they could be used without interruption on a 24/7/365 basis. For example, desktop PCs mostly devoted to office automation tasks and used by administrative staff are only used during work hours, remaining completely unused overnight. Using these resources for other purposes after hours could improve the efficiency of the IT infrastructure.
- Lack of space. The continuous need for additional capacity, whether storage or compute power, makes data centres grow quickly. Companies such as Google and Microsoft expand their infrastructures by building data centres as large as football fields that are able to host thousands of nodes.

- Greening initiatives. Recently, companies are increasingly looking for ways to reduce the amount of energy they consume and to reduce their carbon footprint. Data centers are one of the major power consumers; they contribute consistently to the impact that a company has on the environment. Maintaining a data center operation not only involves keeping servers on, but a great deal of energy is also consumed in keeping them cool. Infrastructures for cooling have a significant impact on the carbon footprint of a data center. Hence, reducing the number of servers through server consolidation will definitely reduce the impact of cooling and power consumption of a data center. Virtualization technologies can provide an efficient way of consolidating servers.
- Rise of administrative costs. Power consumption and cooling costs have now become higher than the cost of IT equipment. Moreover, the increased demand for additional capacity, which translates into more servers in a data center, is also responsible for a significant increment in administrative costs. Computers—in particular, servers—do not operate all on their own, but they require care and feeding from system administrators. Common system administration tasks include hardware monitoring, defective hardware replacement, server setup and updates, server resources monitoring, and backups.

Characteristics of virtualized environments

Virtualization is a concept that refers to the creation of a virtual version of something, whether hardware, a software environment, storage, or a network. In a virtualized environment there are three major components:

1. Guest
2. Host
3. Virtualization layer.

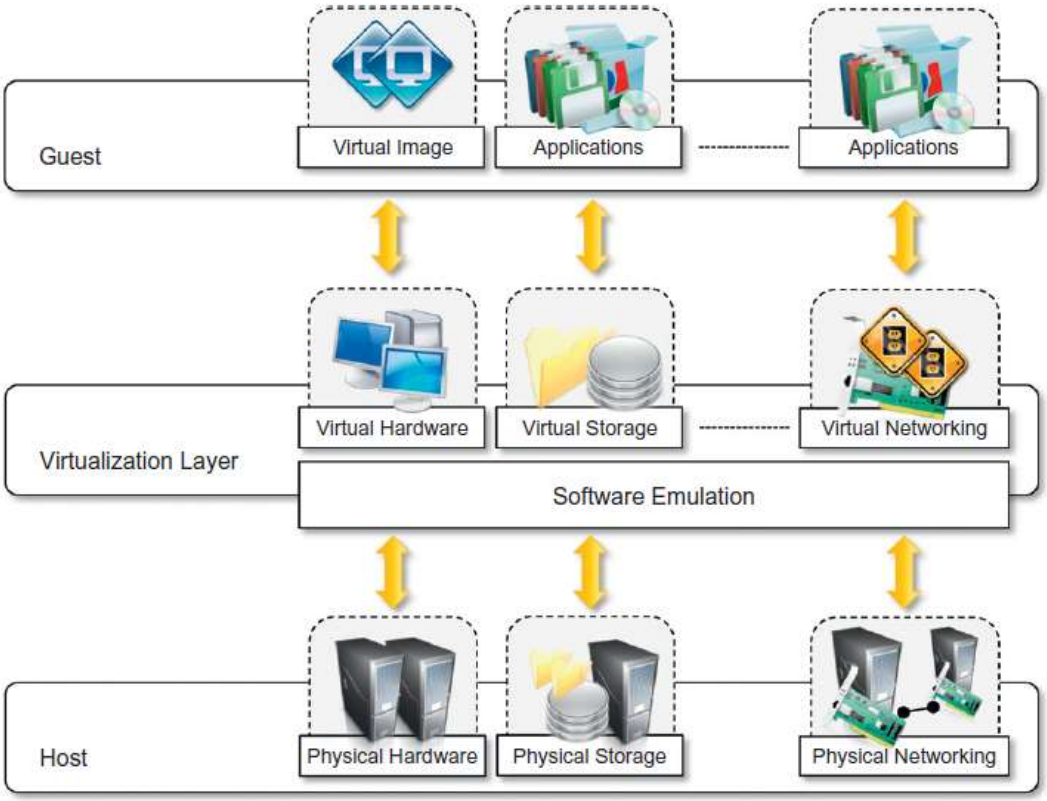
The guest represents the system component that interacts with the virtualization layer. The guest is represented by a system image comprising an operating system and installed applications. These are installed on top of virtual hardware that is controlled and managed by the virtualization layer, also called the virtual machine manager.

The host represents the original environment where the guest is supposed to be managed. The host is represented by the physical hardware, and in some cases the

operating system, that defines the environment where the virtual machine manager is running.

The virtualization layer is responsible for recreating the same or a different environment where the guest will operate.

The main common characteristic of all these different implementations is the fact that the virtual environment is created by means of a software program.



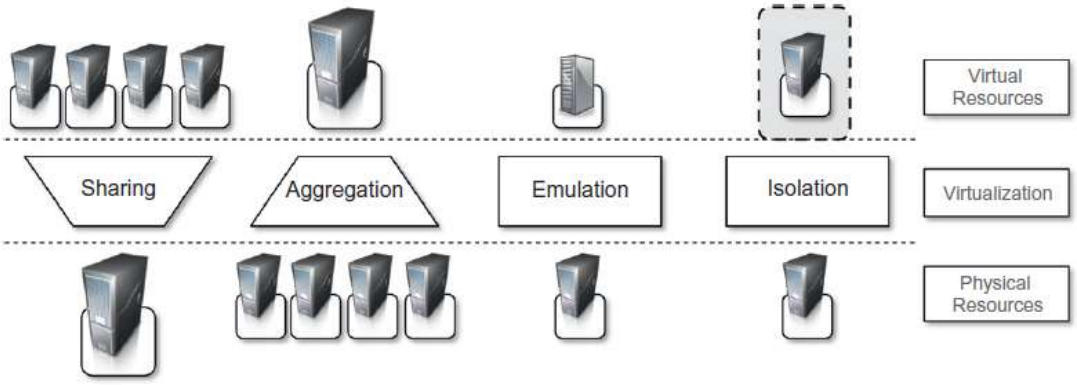
Increased security

The ability to control the execution of a guest in a completely transparent manner opens new possibilities for delivering a secure, controlled execution environment. The virtual machine represents an environment in which the guest is executed. All the operations of the guest are generally performed against the virtual machine, which then translates and applies them to the host. This level of indirection allows the virtual machine manager to control and filter the activity of the guest, thus preventing some harmful operations. 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. Hardware virtualization solutions such as VMware Desktop and VirtualBox provide the ability to create a virtual computer with customized virtual hardware on top of which a new operating system can be installed. By default, the file system exposed by the virtual computer is completely separated from the one of the host machine. This becomes the perfect environment for running applications without affecting other users in the environment.

Managed execution

Virtualization of the execution environment not only allows increased security, but a wider range of features also can be implemented. In particular, sharing, aggregation, emulation, and isolation are the most relevant features.



- Sharing. Virtualization allows the creation of a separate computing environments within the same host. In this way it is possible to fully exploit the capabilities of a powerful guest, which would otherwise be underutilized. Sharing is a particularly important feature in virtualized data centers, where this basic feature is used to reduce the number of active servers and limit power consumption.

- Aggregation. Not only have to share physical resource among several guests, but virtualization also allowed aggregation, which is the opposite process. A group of separate hosts can be tied together and represented to guests as a single virtual host.
- Emulation. Guest programs are executed within an environment that is controlled by the virtualization layer, which ultimately is a program. This allows for controlling and tuning the environment that is exposed to guests. This feature becomes very useful for testing purposes, where a specific guest has to be validated against different platforms or architectures and the wide range of options is not easily accessible during development.

- 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. Isolation brings several benefits; for example, it allows multiple guests to run on the same host without interfering with each other. Second, it provides a separation between the host and the guest.