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**Virtualization** is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources".

In other words, Virtualization is a technique, which allows to share a single physical instance of a resource or an application among multiple customers and organizations. It does by assigning a logical name to a physical storage and providing a pointer to that physical resource when demanded.

What is the concept behind the Virtualization?

Creation of a virtual machine over existing operating system and hardware is known as Hardware Virtualization. A Virtual machine provides an environment that is logically separated from the underlying hardware.

The machine on which the virtual machine is going to create is known as **Host Machine** and that virtual machine is referred as a **Guest Machine**

**BENEFITS OF VIRTUALIZATION**   
1. More flexible and efficient allocation of resources.   
2. Enhance development productivity.   
3. It lowers the cost of IT infrastructure.   
4. Remote access and rapid scalability.   
5. High availability and disaster recovery.   
6. Pay peruse of the IT infrastructure on demand.   
7. Enables running multiple operating systems.

### How virtualization works

Virtualization describes a technology in which an application, [guest OS](https://searchservervirtualization.techtarget.com/definition/guest-OS) or data storage is abstracted away from the true underlying hardware or software.

A key use of virtualization technology is server virtualization, which uses a software layer -- called a hypervisor</a -- to emulate the underlying hardware. This often includes the CPU's memory, input/output (I/O) and network traffic.

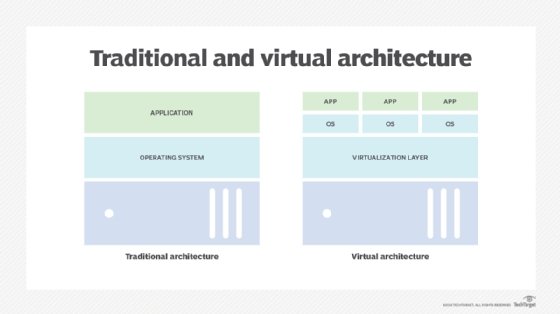
Hypervisors take the physical resources and separate them so they can be utilized by the virtual environment. They can sit on top of an OS or they can be directly installed onto the hardware. The latter is how most enterprises virtualize their systems.

The Xen hypervisor is an open source software program that is responsible for managing the low-level interactions that occur between virtual machines ([VMs](https://searchservervirtualization.techtarget.com/definition/virtual-machine)) and the physical hardware. In other words, the Xen hypervisor enables the simultaneous creation, execution and management of various virtual machines in one physical environment.

With the help of the hypervisor, the guest OS, normally interacting with true hardware, is now doing so with a software emulation of that hardware; often, the guest OS has no idea it's on virtualized hardware.

While the performance of this virtual system is not equal to the performance of the operating system running on true hardware, the concept of virtualization works because most guest operating systems and applications don't need the full use of the underlying hardware.

This allows for greater flexibility, control and isolation by removing the dependency on a given hardware platform. While initially meant for server virtualization, the concept of virtualization has spread to applications, networks, data and desktops.

A side-by-side view of a traditional versus a virtual architecture

The virtualization process follows the steps listed below:

1. Hypervisors detach the physical resources from their physical environments.
2. Resources are taken and divided, as needed, from the physical environment to the various virtual environments.
3. System users work with and perform computations within the virtual environment.
4. Once the virtual environment is running, a user or program can send an instruction that requires extra resources form the physical environment. In response, the hypervisor relays the message to the physical system and stores the changes. This process will happen at an almost native speed.

The virtual environment is often referred to as a guest machine or virtual machine. The VM acts like a single data file that can be transferred from one computer to another and opened in both; it is expected to perform the same way on every computer.

### Types of virtualization

You probably know a little about virtualization if you have ever divided your hard drive into different partitions. A [partition](https://www.techtarget.com/searchstorage/definition/partition) is the logical division of a hard disk drive to create, in effect, two separate hard drives.

There are six areas of IT where virtualization is making headway:

1. [**Network virtualization**](https://searchservervirtualization.techtarget.com/definition/network-virtualization) is a method of combining the available resources in a network by splitting up the available bandwidth into channels, each of which is independent from the others and can be assigned -- or reassigned -- to a particular server or device in real time. The idea is that virtualization disguises the true complexity of the network by separating it into manageable parts, much like your partitioned hard drive makes it easier to manage your files.
2. [**Storage virtualization**](https://www.techtarget.com/searchstorage/definition/storage-virtualization) is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console. Storage virtualization is commonly used in storage area networks.
3. [**Server virtualization**](https://searchservervirtualization.techtarget.com/definition/server-virtualization) is the masking of server resources -- including the number and identity of individual physical servers, processors and operating systems -- from server users. The intention is to spare the user from having to understand and manage complicated details of server resources while increasing resource sharing and utilization and maintaining the capacity to expand later.

The layer of software that enables this abstraction is often referred to as the hypervisor. The most common hypervisor -- Type 1 -- is designed to sit directly on bare metal and provide the ability to virtualize the hardware platform for use by the virtual machines. [KVM virtualization](https://searchservervirtualization.techtarget.com/tip/Cloud-Linux-vendors-cash-in-on-KVM-based-virtualization) is a Linux kernel-based virtualization hypervisor that provides Type 1 virtualization benefits like other hypervisors. KVM is licensed under open source. A Type 2 hypervisor requires a host operating system and is more often used for testing and labs.

1. [**Data virtualization**](https://www.techtarget.com/searchdatamanagement/definition/data-virtualization) is abstracting the traditional technical details of data and data management, such as location, performance or format, in favor of broader access and more resiliency tied to business needs.
2. [**Desktop virtualization**](https://www.techtarget.com/searchvirtualdesktop/definition/desktop-virtualization) is virtualizing a workstation load rather than a server. This allows the user to access the desktop remotely, typically using a [thin client](https://www.techtarget.com/searchnetworking/definition/thin-client) at the desk. Since the workstation is essentially running in a data center server, access to it can be both more secure and portable. The operating system license does still need to be accounted for as well as the infrastructure.
3. [**Application virtualization**](https://www.techtarget.com/searchvirtualdesktop/definition/app-virtualization) is abstracting the application layer away from the operating system. This way, the application can run in an encapsulated form without being depended upon on by the operating system underneath. This can allow a Windows application to run on Linux and vice versa, in addition to adding a level of isolation.

Virtualization can be viewed as part of an overall trend in enterprise IT that includes [autonomic computing](https://www.techtarget.com/whatis/definition/autonomic-computing), a scenario in which the IT environment will be able to manage itself based on perceived activity, and [utility computing](https://www.techtarget.com/searchdatacenter/definition/utility-computing), in which computer processing power is seen as a utility that clients can pay for only as needed. The usual goal of virtualization is to centralize administrative tasks while improving scalability and workloads.

### Advantages of virtualization

The advantages of utilizing a virtualized environment include the following:

* **Lower costs.** Virtualization reduces the amount of hardware servers necessary within a company and data center. This lowers the overall cost of buying and maintaining large amounts of hardware.
* **Easier disaster recovery.** Disaster recovery is very simple in a virtualized environment. Regular snapshots provide up-to-date data, allowing virtual machines to be feasibly backed up and recovered. Even in an emergency, a virtual machine can be migrated to a new location within minutes.
* **Easier testing.** Testing is less complicated in a virtual environment. Even if a large mistake is made, the test does not need to stop and go back to the beginning. It can simply return to the previous snapshot and proceed with the test.
* **Quicker backups.** Backups can be taken of both the virtual server and the virtual machine. [Automatic snapshots](https://searchservervirtualization.techtarget.com/tip/Learn-the-differences-between-VM-snapshot-vs-backup) are taken throughout the day to guarantee that all data is up-to-date. Furthermore, the virtual machines can be easily migrated between each other and efficiently redeployed.
* **Improved productivity.** Fewer physical resources result in less time spent managing and maintaining the servers. Tasks that can take days or weeks in a physical environment can be done in minutes. This allows staff members to spend the majority of their time on more productive tasks, such as raising revenue and fostering business initiatives.

### Benefits of virtualization

Virtualization provides companies with the benefit of maximizing their output. Additional benefit for both businesses and data centers include the following:

* **Single-minded servers.** Virtualization provides a cost-effective way to separate email, database and web servers, creating a more comprehensive and dependable system.
* **Expedited deployment and redeployment.** When a physical server crashes, the backup server may not always be ready or up to date. There also may not be an image or clone of the server available. If this is the case, then the redeployment process can be time-consuming and tedious. However, if the data center is virtualized, then the process is quick and fairly simple. Virtual backup tools can expedite the process to minutes.
* **Reduced heat and improved energy savings.** Companies that use a lot of hardware servers risk overheating their physical resources. The best way to prevent this from happening is to decrease the number of servers used for [data management](https://www.techtarget.com/searchdatamanagement/definition/data-management), and the best way to do this is through virtualization.
* **Better for the environment.** Companies and data centers that utilize copious amounts of hardware leave a large carbon footprint; they must take responsibility for the pollution they are generating. Virtualization can help reduce these effects by significantly decreasing the necessary amounts of cooling and power, thus helping clean the air and the atmosphere. As a result, companies and data centers that virtualize will improve their reputation while also enhancing the quality of their relationship with customers and the planet.
* **Easier migration to the cloud.** Virtualization brings companies closer to experiencing a completely cloud-based environment. Virtual machines may even be deployed from the data center in order to build a cloud-based infrastructure. The ability to embrace a cloud-based mindset with virtualization makes migrating to the cloud even easier.
* **Lack of vendor dependency.** Virtual machines are [agnostic](https://www.techtarget.com/whatis/definition/agnostic) in hardware configuration. As a result, virtualizing hardware and software means that a company does not need to depend on a vendor for these physical resources.

### Limitations of virtualization

Before converting to a virtualized environment, it is important to consider the various upfront costs. The necessary investment in virtualization software, as well as hardware that might be required to make the virtualization possible, can be costly. If the existing infrastructure is more than five years old, an initial renewal budget will have to be considered.

Fortunately, many businesses have the capacity to accommodate virtualization without spending large amounts of cash. Furthermore, the costs can be offset by collaborating with a [managed service provider](https://www.techtarget.com/searchitchannel/definition/managed-service-provider) that provides monthly leasing or purchase options.

There are also **software licensing considerations** that must be considered when creating a virtualized environment. Companies must ensure that they have a clear understanding of how their vendors view software use within a virtualized environment. This is becoming less of a limitation as more software providers adapt to the increased use of virtualization.

Converting to virtualization takes time and may come with a learning curve. Implementing and controlling a virtualized environment demands each IT staff member to be trained and possess expertise in virtualization. Furthermore, some applications do not adapt well when brought into a virtual environment. The IT staff will need to be prepared to face these challenges and should address them prior to converting.

There are also [security risks involved with virtualization](https://www.techtarget.com/searchitoperations/tip/Follow-this-10-point-virtualization-security-checklist). Data is crucial to the success of a business and, therefore, is a common target for attacks. The chances of experiencing a data breach significantly increase while using virtualization.

Finally, in a virtual environment, users lose control of what they can do because there are several links that must collaborate to perform the same task. If any part is not working, then the entire operation will fail.

**Pros of Virtualization in Cloud Computing :**

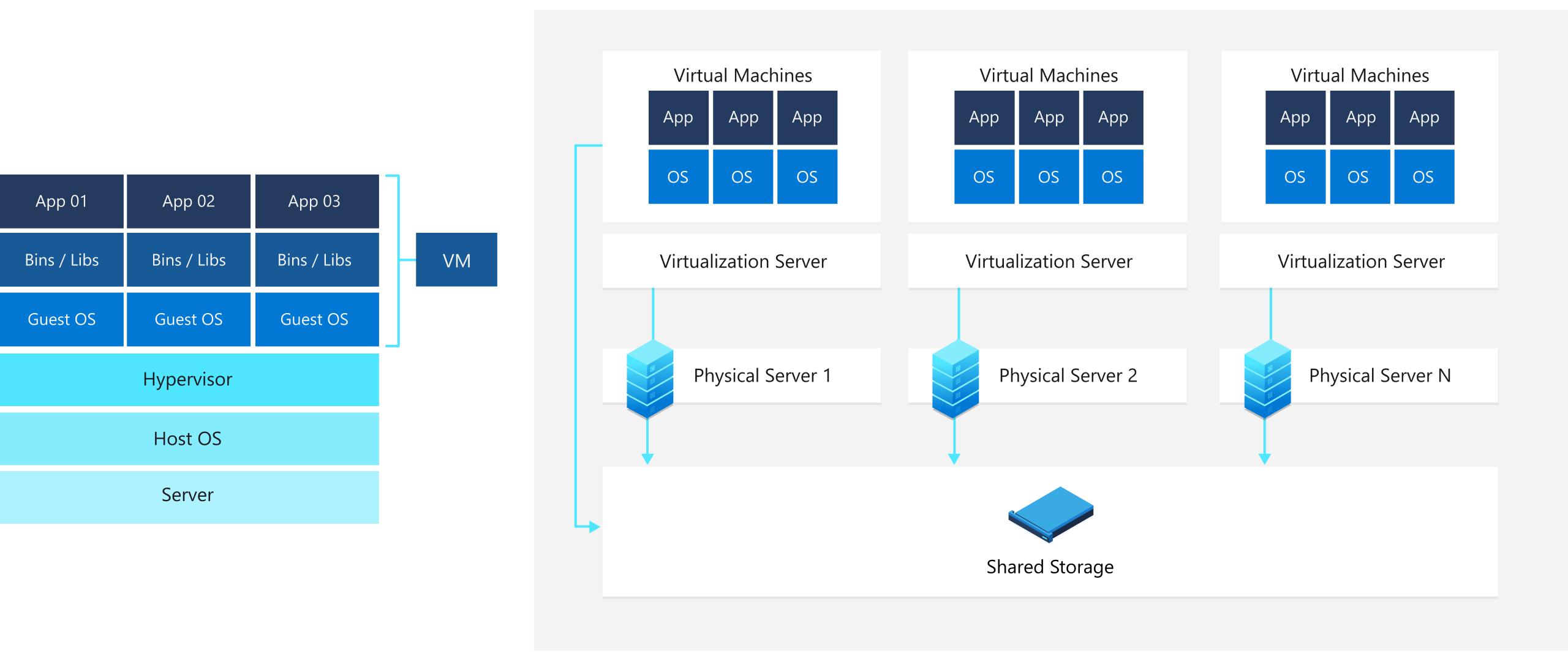
* **Utilization of Hardware Efficiently –**  
  With the help of Virtualization Hardware is Efficiently used by user as well as Cloud Service Provider. In this the need of Physical Hardware System for the User is decreases and this results in less costly.In Service Provider point of View, they will vitalize the Hardware using Hardware Virtualization which decrease the Hardware requirement from Vendor side which are provided to User is decreased. Before Virtualization, Companies and organizations have to set up their own Server which require extra space for placing them, engineer’s to check its performance and require extra hardware cost but with the help of Virtualization the all these limitations are removed by Cloud vendor’s who provide Physical Services without setting up any Physical Hardware system.
* **Availability increases with Virtualization –**  
  One of the main benefit of Virtualization is that it provides advance features which allow virtual instances to be available all the times. It also has capability to move virtual instance from one virtual Server another Server which is very tedious and risky task in Server Based System. During migration of Data from one server to another it ensures its safety. Also, we can access information from any location and any time from any device.
* **Disaster Recovery is efficient and easy –**  
  With the help of virtualization Data Recovery, Backup, Duplication becomes very easy. In traditional method , if somehow due to some disaster if Server system Damaged then the surety of Data Recovery is very less. But with the tools of Virtualization real time data backup recovery and mirroring become easy task and provide surety of zero percent data loss.
* **Virtualization saves Energy –**  
  Virtualization will help to save Energy because while moving from physical Servers to Virtual Server’s, the number of Server’s decreases due to this monthly power and cooling cost decreases which will Save Money as well. As cooling cost reduces it means carbon production by devices  also decreases which results in Fresh and pollution free environment.
* **Quick and Easy Set up –**  
  In traditional methods Setting up physical system and servers are very time-consuming. Firstly Purchase them in bulk after that wait for shipment. When Shipment is done then wait for Setting up and after that again spend time in installing required software etc. Which will consume very time. But with the help of virtualization the entire process is done in very less time which results in productive setup.
* **Cloud Migration becomes easy –**  
  Most of the companies those who already have spent a lot in the server have a doubt of Shifting to Cloud. But it is more cost-effective to shift to cloud services because all the data that is present in their server’s can be easily migrated into the cloud server and save something from maintenance charge, power consumption, cooling cost, cost to Server Maintenance Engineer etc.

**Cons of Virtualization :**

* **Data can be at Risk –**  
  Working on virtual instances on shared resources means that our data is hosted on third party resource which put’s our data in vulnerable condition. Any hacker can attack on our data or try to perform unauthorized access. Without Security solution our data is in threaten situation**.**
* **Learning New Infrastructure –**  
  As Organization shifted from Servers to Cloud. They required skilled staff who can work with cloud easily. Either they hire new IT staff with relevant skill or provide training on that skill which increase the cost of company.
* **High Initial Investment –**  
  It is true that Virtualization will reduce the cost of companies but also it is truth that Cloud have high initial investment. It provides numerous services which are not required and when unskilled organization will try to set up in cloud they purchase unnecessary services which are not even required to them.

**Virtual machines: virtual computers within computers**

A virtual machine, commonly shortened to just VM, is no different than any other physical computer like a laptop, smart phone, or server. It has a CPU, memory, disks to store your files, and can connect to the internet if needed. While the parts that make up your computer (called hardware) are physical and tangible, VMs are often thought of as virtual computers or software-defined computers within physical servers, existing only as code.



**How does a virtual machine work?**

Virtualization is the process of creating a software-based, or "virtual" version of a computer, with dedicated amounts of CPU, memory, and storage that are "borrowed" from a physical host computer—such as your personal computer— and/or a remote server—such as a server in a cloud provider's datacenter. **A virtual machine is a computer file, typically called an image, that behaves like an actual computer.** It can run in a window as a separate computing environment, often to run a different operating system—or even to function as the user's entire computer experience—as is common on many people's work computers. The virtual machine is partitioned from the rest of the system, meaning that the software inside a VM can't interfere with the host computer's primary operating system.

**What are VMs used for?**

Here are a few ways virtual machines are used:

* Building and deploying apps to the cloud.
* Trying out a new operating system (OS), including beta releases.
* Spinning up a new environment to make it simpler and quicker for developers to run dev-test scenarios.
* Backing up your existing OS.
* Accessing virus-infected data or running an old application by installing an older OS.
* Running software or apps on operating systems that they weren't originally intended for.

**What are the benefits of using VMs?**

While virtual machines run like individual computers with individual operating systems and applications, they have the advantage of remaining completely independent of one another and the physical host machine. A piece of software called a hypervisor, or virtual machine manager, lets you run different operating systems on different virtual machines at the same time. This makes it possible to run Linux VMs, for example, on a Windows OS, or to run an earlier version of Windows on more current Windows OS.

And, because VMs are independent of each other, they're also extremely portable. You can move a VM on a hypervisor to another hypervisor on a completely different machine almost instantaneously.

Because of their flexibility and portability, virtual machines provide many benefits, such as:

* **Cost savings**—running multiple virtual environments from one piece of infrastructure means that you can drastically reduce your physical infrastructure footprint. This boosts your bottom line—decreasing the need to maintain nearly as many servers and saving on maintenance costs and electricity.
* **Agility and speed**—Spinning up a VM is relatively easy and quick and is much simpler than provisioning an entire new environment for your developers. Virtualization makes the process of running dev-test scenarios a lot quicker.
* **Lowered downtime**—VMs are so portable and easy to move from one hypervisor to another on a different machine—this means that they are a great solution for backup, in the event the host goes down unexpectedly.
* **Scalability**—VMs allow you to more easily scale your apps by adding more physical or virtual servers to distribute the workload across multiple VMs. As a result you can increase the availability and performance of your apps.
* **Security benefits**— Because virtual machines run in multiple operating systems, using a guest operating system on a VM allows you to run apps of questionable security and protects your host operating system. VMs also allow for better security forensics, and are often used to safely study computer viruses, isolating the viruses to avoid risking their host computer.

# Virtualization | Xen: Paravirtualization

**Xen** is an open source hypervisor based on paravirtualization. It is the most popular application of paravirtualization. Xen has been extended to compatible with full virtualization using [hardware-assisted virtualization](https://www.geeksforgeeks.org/hardware-based-virtualization/). **It enables high performance to execute guest operating system.** This is probably done by removing the performance loss while executing the instructions requiring significant handling and by modifying portion of the guest operating system executed by Xen, with reference to the execution of such instructions. Hence this especially support x86, which is the most used architecture on commodity machines and servers.

**Pros:**

* **a)**Xen server is developed over open-source Xen hypervisor and it uses a combination of hardware-based virtualization and paravirtualization. This tightly coupled collaboration between the operating system and virtualized platform enables the system to develop lighter and flexible hypervisor that delivers their functionalities in an optimized manner.
* **b)**Xen supports balancing of large workload efficiently that capture CPU, Memory, disk input-output and network input-output of data. It offers two modes to handle this workload: Performance enhancement, and For handling data density.
* **c)**It also comes equipped with a special storage feature that we call Citrix storage link. Which allows a system administrator to uses the features of arrays from Giant companies- Hp, Netapp, Dell Equal logic etc.
* **d)**It also supports multiple processor, Iive migration one machine to another, physical server to virtual machine or virtual server to virtual machine conversion tools, centralized multiserver management, real time performance monitoring over window and linux.

**Cons:**

* **a)**Xen is more reliable over linux rather than on window.
* **b)**Xen relies on 3rd-party component to manage the resources like drivers, storage, backup, recovery & fault tolerance.
* **c)**Xen deployment could be a burden some on your Linux kernel system as time passes.
* **d)**Xen sometimes may cause increase in load on your resources by high input-output rate and and may cause starvation of other Vm’s.

# Virtualization | VMware: Full Virtualization

In full virtualization primary hardware is replicated and made available to the guest operating system, which executes unaware of such abstraction and no requirements to modify. Technology of VMware is based on the key concept of Full Virtualization. Either in desktop environment, with the help of [type-II hypervisor](https://www.geeksforgeeks.org/hypervisor/), or in server environment, through [type-I hypervisor](https://www.geeksforgeeks.org/hypervisor/), VMware implements full virtualization. In both the cases, full virtualization is possible through the direct execution for non-sensitive instructions and binary translation for sensitive instructions or hardware traps, thus enabling the virtualization of architecture like x86.

**Advantages of Binary Translation –** 

1. This kind of virtualization delivers the best isolation and security for Virtual Machine.
2. Truly isolated numerous guest OS can execute concurrently on the same hardware.
3. It is only implementation that needs no hardware assist or operating system assist to virtualize sensitive instruction as well as privileged instruction.

**Disadvantages of Binary Translation –** 

1. It is time consuming at run-time.
2. It acquires a large performance overhead.
3. It employs a code cache to stock the translated most used instructions to enhance the performance, but it increases memory utilization along with the hardware cost.
4. The performance of full virtualization on the x86 architecture is 80 to 95 percent that of the host machine.

Open Source Virtualization Manager

**6 open source virtualization technologies to know in 2020**

This table summarizes each Virt Tool, including license information and links to each tool's website and source code. Much of this information comes from the Virt Tools website and each tool's site.

| **Name** | **What It Is** | **License** | **Source Code** |
| --- | --- | --- | --- |
| [Kernel-based Virtual Machine (KVM)](https://www.linux-kvm.org/page/Main_Page) | A virtualization module in the Linux kernel that allows the kernel to function as a hypervisor | GNU GPL or LGPL | [Source code](https://git.kernel.org/pub/scm/virt/kvm/kvm.git) |
| [Quick Emulator (QEMU)](https://www.qemu.org/) | A generic and open source machine emulator and virtualizer | GPLv2 | [Source code](https://git.qemu.org/git/qemu.git) |
| [Libvirt](https://libvirt.org/) | A library and daemon providing a stable, open source API for managing virtualization hosts | GNU | [Source code](https://libvirt.org/git/?p=libvirt.git) |
| [Libguestfs](http://libguestfs.org/) | A set of tools for accessing and modifying VM disk images | LGPL, GPL | [Source code](https://github.com/libguestfs/libguestfs) |
| [Virt-manager](https://virt-manager.org/) | A desktop user interface for managing VMs through libvirt | GPLv2+ | [Source code](https://github.com/virt-manager/virt-manager) |
| [Libosinfo](https://libosinfo.org/download/) | Provides a database of information about operating system releases to assist in optimally configuring hardware when deploying VMs | LGPLv2+ | [Source code](https://gitlab.com/libosinfo/libosinfo) |

**Kernel-based Virtual Manager (KVM)**

KVM is a full virtualization solution for Linux on hardware containing virtualization extensions. KVM provides the hardware virtualization for a wide variety of guest operating systems, including Linux, Windows, macOS, ReactOS, and Haiku. Using KVM, you can run multiple VMs on unmodified Linux or Windows images. Each VM has private virtualized hardware: a network card, disk, graphics adapter, etc.

Most of the time, you won't directly interact with KVM. Instead, you must use QEMU, virt-manager, or another virtualization management tool to leverage KVM.

**Quick Emulator (QEMU)**

QEMU is a generic, open source machine emulator and virtualizer. When used as an emulator, QEMU can run operating systems and programs made for one machine (e.g., an ARM board) on a different machine (e.g., your own x86\_64 PC). When used as a virtualizer, QEMU achieves near-native performance by executing the guest code directly on the host CPU using KVM.

**Libvirt**

Libvirt is a library and daemon that provides a stable open source API for managing virtualization hosts. It targets multiple hypervisors, including QEMU, KVM, LXC, Xen, OpenVZ, VMWare ESX, VirtualBox, and more.

**Libguestfs**

Libguestfs is a set of tools for accessing and modifying VM disk images. You can use it for viewing and editing files inside guests; scripting changes to VMs; monitoring disk used/free statistics; creating guests, physical to virtual (P2V), or virtual to virtual (V2V) machines; performing backups; cloning VMs; building VMs; formatting disks; resizing disks; and much more.

**Virt-manager**

Virt-manager is a desktop user interface for managing VMs through libvirt. It primarily targets KVM VMs but also manages Xen and LXC. It also includes the command line provisioning tool virt-install. Think of virt-manager as an easy-to-use management tool for your VMs. For example, you can use virt-manager to run a Microsoft Windows environment on a Linux workstation or vice versa.

**Libosinfo**

Libosinfo provides a database of information about operating system releases to assist in configuring hardware when deploying VMs. It includes a C library for querying information in the database, which is also accessible from any language supported by GObject introspection. As you may guess, libosinfo is more of a building block to enable an operating system's functionality—but quite an important one.