Server Virtualization

HOW VIRTUALIZATION WORKS

Server virtualization enables companies to reduce costs and improve data center efficiency by leaps and bounds. If you’re new to virtualization, this primer outlines the concepts you need to know. BY DAVID DAVIS
Server virtualization will make your company more efficient, save it money and enable your IT department to accomplish things with IT infrastructure that you never thought were possible. Because virtualization abstracts physical resources into virtual ones, it gives data centers far more flexibility and the potential for greater operational efficiency. In today’s always-on economy, better use of technology resources can easily translate into competitive advantage.

Server virtualization divides a physical server into multiple virtual servers, known as virtual machines (VMs), using a hypervisor such as VMware vSphere, Microsoft Hyper-V or Citrix XenServer. It doesn’t have to be complex to use, but virtualization introduces several new concepts and terms that you need to understand to truly get how this technology works.

If you’re an executive considering purchasing virtualization technologies or an IT professional who wants to know more about how virtualization works, this article explores the basics to get you started. It outlines the building blocks so you can make smart purchasing decisions or bring virtualization technologies to your company’s data center.
WHAT’S A HYPERVISOR, ANYWAY?
The most crucial piece of any virtual infrastructure is the hypervisor, which is what makes server virtualization possible. A hypervisor creates a virtual host that hosts virtual machines. It is also responsible for creating the virtual hardware that VMs will use.

If you look up the term hypervisor, the definition will likely say that a hypervisor is an “abstraction layer.” That’s because it abstracts the traditional server operating system (OS) from the server hardware. Another way of saying this is that the hypervisor decouples the OS from the hardware. Your server OS no longer has to be tied to physical hardware, and the newly virtualized server can be hardware-independent and containerized inside a virtual machine.

Now, before we discuss virtual machines, let’s review the two kinds of hypervisors: Type 1 and Type 2 hypervisors (see Figure 1).

A Type 1 hypervisor is installed directly on physical server hardware, thus replacing the existing OS. This is the most efficient design, in that it offers the best performance as well as the most enterprise-level data center features. If you

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**Figure 1:** A depiction of the difference between Type 1 and Type 2 hypervisors

SOURCE: WIKIPEDIA
are virtualizing servers in your data center, you would use a Type 1 hypervisor. Examples of Type 1 hypervisors are VMware vSphere and Microsoft Hyper-V.

A **Type 2 hypervisor** is installed and “hosted” by the existing OS. This is less efficient but enables you to keep existing applications already installed on the host. The best way to use a Type 2 hypervisor is to install the hypervisor on an existing desktop or laptop system for testing and development using virtualization. Examples of Type 2 hypervisors are VMware Workstation, VMware Fusion and Windows Virtual PC.

**BRING ON THE VIRTUAL MACHINES**

A virtual machine runs on a virtual host. Most IT professionals use server virtualization to **consolidate physical servers into virtual servers**. In this case, VMs are virtualized copies of physical servers (see **Figure 2**).
In Figure 2, on top of the physical server, the virtualization layer is loaded—and, in this example, the hypervisor is VMware-based. Virtual machines sit on top of the hypervisor, each with its own OS and applications.

To put it another way, a virtual host (or host) is what virtual guests (or guests) run on top of. In each guest, the OS that you install has no idea that it runs inside a virtual host. The guest OS just behaves as though it runs on a physical server. But if you look closely, you’ll see that the hardware detected by the guest OS is “virtual hardware,” such as “virtual CPU,” “virtual memory,” “virtual disk” and “virtual network interface card.” **Figure 3** shows how virtual machine hardware appears to a virtual host.

**Figure 3:** The configuration of a virtual machine’s hardware from the perspective of a virtual host

*Source: David Davis*
This VM has 4 GB of virtual memory, two virtual CPUs, a virtual hard drive and a virtual network connection. Inside the virtual machine, the virtual hardware functions just like real physical hardware until you note the hardware descriptions (see Figure 4).

This VM has a VMware virtual disk device, a VMware video graphics array adapter and a VMware DVD/CD-ROM drive.

By providing virtual devices to virtual guests, a virtual host (or hypervisor) enables guests to share a physical server’s resources and allows you to configure resource scheduling to provide the highest-priority servers with the most resources.
So, as an example, a hypervisor may schedule multiple virtual CPUs from multiple virtual machines across just one physical CPU with just two or four CPU cores. A hypervisor allows you to allocate 32 GB of virtual memory to virtual machines running on a physical host that has only 16 GB of physical memory.

**ASSEMBLING THE PUZZLE PIECES OF A VIRTUAL INFRASTRUCTURE**

So far we have discussed how a hypervisor makes a virtualization layer on a physical server to create virtual machines and how these VMs (or guests) contain existing servers in a virtualized format. What else do you need to complete the virtual puzzle?

At minimum, to use a Type 1 hypervisor and create a virtual host, you need the following:

- a physical server with local storage;
- a Type 1 hypervisor loaded on the physical server;
- a management application run from a remote computer, such as an administrator's workstation; and
- a virtual machine.

Most companies quickly outgrow a single virtual host and need additional ones so they can add more virtual machines and use advanced features such as high availability. Once you go beyond a single host to multiple ones, it makes sense to have a centralized management application for the entire virtual infrastructure. And in fact, most administrators spend the bulk of their time using a virtualization management application to monitor and configure virtual infrastructure.

Each of the major hypervisor vendors on the market has its own centralized management application. VMware's is vCenter, for vSphere (its hypervisor). Microsoft’s is System Center Virtual Machine Manager (SCVMM) for Hyper-V (its hypervisor). These centralized management applications provide the following benefits:
- a single point of control for all hosts;
- the ability to define multiple users, groups and various administrative roles for virtual infrastructure; and
- the option to use advanced features and third-party applications that one cannot use without a centralized point of control.

For example, in Figure 5, the vSphere Client is running and connected to vCenter centralized management server. It’s administering two virtual hosts, each with multiple VMs running inside.

**THE IMPORTANCE OF SHARED STORAGE**
Along with the other pieces of a successful virtual environment—multiple servers, a hypervisor, virtual machines, centralized management, administra-
tive client and network infrastructure—shared storage is now more important than ever. Because virtual machines are hardware-independent, they can easily be moved from host to host. Advanced features such as load balancing, high availability, and backup and restore take advantage of this newfound hardware independence, but these VMs need to be stored in a central location to which all virtual hosts have access.

Because advanced features need shared storage, it’s now required to implement an enterprise-grade virtual infrastructure. For many companies that have never needed shared storage, they may first have exposure to it when they implement a virtual infrastructure. If you plan to go beyond a single server with your virtual infrastructure, you need to consider shared storage in your planning. Options for shared storage include the following:

- **a Fibre Channel storage area network**: a dedicated, block-based storage network that uses its own switches, storage array and adapters on each server and is likely the most costly of the options;

- **an iSCSI storage area network**: a block-based storage area network that uses an existing Ethernet network to communicate with an iSCSI storage array, which could be a high-end hardware array or a low-end virtual storage appliance;

- **an NFS network-attached storage**: a file-based storage option that is likely the easiest option to configure. Network File System, or NFS, scales from low-end to high-end performance and cost.

### Advanced Management Features

By virtualizing servers, you’ll not only reduce your number of physical servers but also have access to advanced virtualization features. Here are some common virtualization management features:

- **Resource sharing and allocation.** Hypervisors allow resource sharing, and
some, such as VMware vSphere, offer memory-optimization techniques to enable memory overcommitment. Further, as an administrator, you can allocate additional resources to tier-one VMs to ensure the best quality of service.

**Virtual machine portability.** With hardware independence, VMs can be moved from a local Type 2 hypervisor to a Type 1 virtual infrastructure in a data center. You can copy VMs from production to test and development environments or from production to disaster recovery (DR) virtual infrastructures quickly and easily. This portability also enables many other features.

**Load balancing.** With portability, VMs can be automatically moved from one host to another without creating downtime and whenever a virtual host fails to provide the resources VMs need.

**High availability.** If VMs’ current host fails, these virtual servers can be automatically restarted on another host.

**Easier backup and restore.** A hypervisor can track the blocks of a VM disk that have been changed so that only those blocks are backed up. Plus, with snapshot functionality, virtual machines can be backed up anytime without affecting user performance.

**Fast provisioning.** Virtual machines can be easily and quickly cloned to create new VMs in seconds whenever needed. This way, new enterprise applications can be brought back up to run faster than previously.

**Simplified disaster recovery.** Because virtual machines are hardware-independent and portable, all you need to do is back them up. Then, if there is a disaster, they can be restored on any host. You no longer need 1:1 server mapping from production to the DR site. Additionally, the changed blocks of a virtual machine disk file can be easily replicated from production to DR to make replication easier than ever before.
**Hypercloud.** With hardware independence and portability, service providers have sprung up to offer **Infrastructure as a Service (IaaS)**. These technologies enable you to easily import VMs and run them in the cloud, accessing them over the Internet or through a VPN to create a **hybrid cloud**.

**Figure 6** features a VMware graphic that illustrates how physical servers would be loaded with the VMware vSphere hypervisor, how it would offer the

![Figure 6: A depiction of a virtualized infrastructure and its potential benefits](source: vmware inc.)
advanced features discussed, how the environment would be managed with VMware vCenter and how VMs and applications benefit.

THE BENEFITS OF SERVER VIRTUALIZATION

Server virtualization works by replacing the existing server OS with a hypervisor, or “virtualization layer,” and enables you to run multiple virtual machines—each with its own operating system and applications—on the same physical server. Once servers are virtualized, you gain hardware independence and portability of these servers. That portability allows you to take advantage of many advanced virtualization features—features that enable companies’ data centers to become more efficient, dynamic and scalable.

Although plenty of space could be devoted to the use cases for and the benefits of server virtualization, let’s just summarize the most critical ones here:

- fewer servers are required for the same number of applications;
- reduced power consumption;
- less maintenance overhead for IT staff;
- improved resource utilization;
- easier and faster process to add server capacity;
- easier patch management and upgrades; and
- simpler disaster recovery planning without disruption to the production environment.

Because virtualized resources consume less power and can be moved easily, server virtualization can reduce costs and improve IT resource use and management. Virtual machines can be added in seconds to power new applications for your business. With no downtime for end users, critical business workloads can be moved from one server to another to balance the load or before a server fails.

But ultimately, the greatest benefit of server virtualization is that it makes you tremendously more efficient. So why wouldn’t you want to introduce it to your data center?
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