# VIRTUALIZATION

## *IS IT RIGHT FOR YOU?*


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## IS IT RIGHT FOR YOU?

Recently the technical vendor community has been abuzz with the concept of virtualization. Articles and advertisements abound describing the benefits and the miracle cost savings possible by "Going Green". This is the latest "new thing".

## BACKGROUND

However, virtualization is not a new idea; it was first introduced on the IBM System/370 mainframe in 1972. Virtualization of computers using 32-bit or 64-bit x86 architecture is new. The proliferation of x86 servers and resulting potential for server consolidation (virtualization allows a single server to replace multiple underutilized dedicated servers) rekindled interest in virtualization. While many definitions of virtualization are in use, here we'll restrict our comments to Virtual Machines.

Historically software, especially the computer operating system, is tied to hardware. We are all familiar with the "recommended minimum system requirements" section of software documentation that spells out CPU, RAM, hard disk storage free space and other computer system hardware specifications. Over time, computer system manufacturers and OS vendors (e.g. Microsoft) developed a close relationship: OEMs only sell workstation computers with the operating system (OS) installed and that OS is only licensed to be used on that computer system hardware.

## WHAT IS A VIRTUAL MACHINE?

Virtualization technologies provide a way to separate the physical hardware (computer) and software (OS and applications) by emulating hardware using software.

**Say that again - in English**

### *How does it work?*

Essentially, software (called a hypervisor) is loaded on a computer. That software in-turn loads files that define a new ***virtual*** computer called a Virtual Machine (VM).

Because a ***virtual*** computer is in reality a data file, not a physical computer, it can be copied, moved to another computer etc, just like any other file. Typically, virtual computers use two file structures – one defines the hardware, the other the hard disk. Additionally some hypervisor technologies can be configured to cache changes to the virtual hardware or the virtual hard disk for writing (called committing) at a later time. This provides the ability to discard changes to the operating system, permitting boot from a known and controlled valid state.

## WHAT DO THESE ABILITIES DO FOR ME?

1. This means you can have multiple copies of a working computer configuration that can be run on any physical machine (computer) provided that machine has appropriate virtual technology installed. Additional copies of the working computer can be created by simply copying the files.

   **Example 1:** A hospital uses thin client workstations employing a wireless connection on wheeled carts with the desktop hosted on a centralized server.

   **Example 2:** A company sets up a "test" network composed entirely of virtual machines to test patch compatibility with existing production applications.

   **Example 3:** The technical support department (a staff of 1 using one workstation) sets up virtual machines with operating systems which mirror departmental workstations, permitting the support staff to "see" just what the production staff sees, even when using deprecated operating systems such as Windows 98.

   **Example 4:** Employees are issued a virtual computer that fits on a thumb drive and can be run on any computer on which the hypervisor is installed.

   There are also profound implications for business continuity/disaster recovery/backup and other enterprise wide system management processes.

2. This means you can have multiple computers each dedicated to a single task running on one physical computer. Here is where we see most of the "action": Data Center Consolidation also called Server Consolidation. Virtualization can be an answer to a problem called server sprawl which many mid- and large sized organizations experience.

   You know the drill: get a new application, deploy it on its own server. After a surprisingly short time, you have several servers. The problem is increased system maintenance, another item of hardware to be placed into the HW replacement policy pool, increased infrastructure costs: higher electrical and cooling costs, increased requirements for floor space and networking resources. The real costs of server sprawl lie in the administration—each penny spent on hardware costs a dollar to manage. Lastly, most of these dedicated servers have utilization levels ranging from 5 to 20 percent. This is great for response time but some feel this leads to underutilization of the technology.

   Outsourcing to a web-app might be one solution, but what if you don't want to give up control?

   **Businessperson**: Am I really getting my money's worth out of this expensive equipment?
   **Vendor Rep:** How many servers do you have? How about we put them all on just one!

   Vendors often use the idea of capturing seemingly significant cost savings as a sales tool justifying adoption of Virtualization Technologies by business.

### THE UPSIDE

At first blush all of this seems wonderful. Low or no cost deployment, operational cost savings, utility cost savings, space savings and full utilization of expensive processing power!

### THE DOWNSIDE

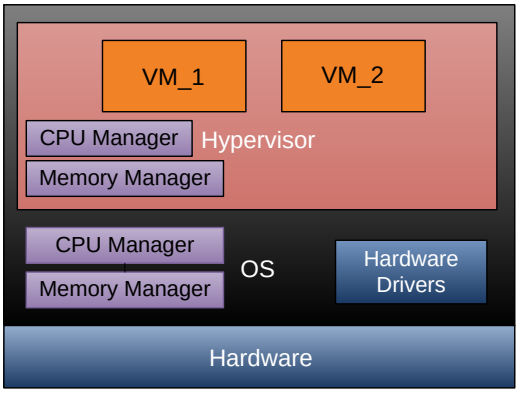
Unfortunately, there is no free lunch and there is no one-size-fits-all solution. Virtualization technologies are complex. Unfortunately, complexity usually is expensive.

As with any Business project (there are no IT projects, only Business projects), success requires careful planning by business staff, management and technicians – and an additional layer of technology is present.

This additional layer requires additional management effort and new technical skills. The additional management effort also increases cost.

## TELL ME MORE – VIRTUALIZATION MODELS

**HOSTED VIRTUALIZATION**




Hosted virtualization approach relies on having an existing operating system (OS) in place. The hypervisor runs on top of the OS, and the virtual machines (VM) are managed by the hypervisor. Note that there is a memory manager and central processing unit (CPU) manager (scheduler) in both the hypervisor and the host OS. This creates a large amount of overhead.

### Advantages:

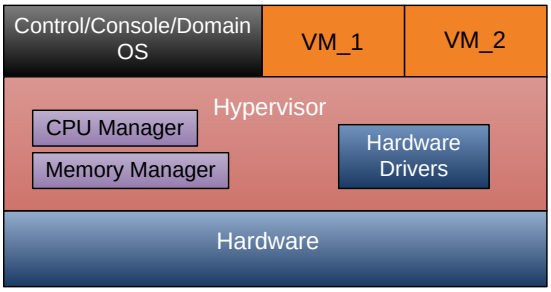
- Virtualization product is installed onto the host desktop just as any other application
- The host desktop OS can continue to be used
- Uses the host OS's device drivers - the virtualization product supports whatever hardware the host does.
- VM OS can be different than the host OS

### Disadvantages:

- Slow performance.

Virtualization products, such as VMware Workstation, VMware Fusion, Microsoft Virtual PC, Microsoft Virtual Server and Parallels Desktop for the Mac, implement hosted virtualization architecture. Most of these products are designed to virtualize the desktop (workstation).

### BARE-METAL VIRTUALIZATION




Here the hypervisor sits directly on top of the hardware—hence the term "bare-metal virtualization." Note that hardware device drivers are part of the hypervisor and that only one CPU/Memory manager is present.

#### Advantages:

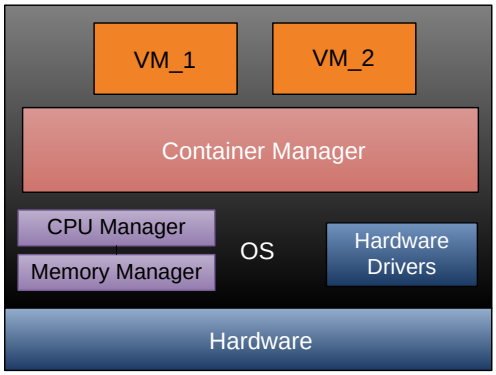
- Performance
- Products are distributed as appliances or server OSes. For example: you simply boot the server with an installation CD-ROM and the product installs on the hard drive without having to load/configure an existing OS. Turn the server on and it configures itself for the virtualization infrastructure. However, these features are not related to the architecture itself.

#### Disadvantages

- Vendor publishes a hardware compatibility list (HCL) that dictates what hardware can be used with their virtualization product. This is because in order to keep the hypervisor as small in size as possible, the number of device drivers in the hypervisor kernel is kept to a minimum.

Many data centers implement bare-metal products. VMware ESX and Citrix Xen Server are examples of bare-metal virtualization architecture.

### OPERATING SYSTEM (OS) VIRTUALIZATION




OS virtualization divides a single host OS into containers and uses a container manager for management. It does not use a traditional hypervisor to manage VMs.

### Advantages:

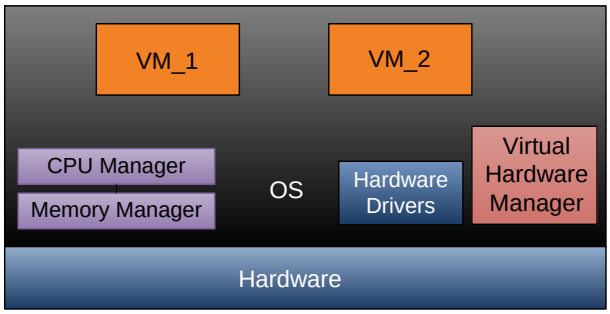
- Performance
- Reduced disk space requirements, containers can use the same files

### Disadvantages:

- The VM OS must be the same OS as the host OS.

Products that use OS virtualization are Parallels Virtuozzo and Solaris Containers.

**HYBRID VIRTUALIZATION**




Hybrid virtualization uses a host OS like hosted virtualization, but instead of running a hypervisor on top of the host OS, a Kernel-level virtualization driver is inserted into the host OS kernel. This driver acts as a Virtual Hardware Manager (VHM sometimes called a Virtual Machine Monitor), coordinating hardware access between the VMs and the host OS. Because the VHM accesses hardware directly, especially the CPU, Hybrid virtualization is also called Hardware-Assisted Virtualization.

Because they operate differently than other Virtual Machines, Virtual Machines employing this architecture are called Kernel-based Virtual Machine (KVM) by some, particularly Unix/Linux vendors.

Note that hybrid virtualization uses the memory manager and CPU manager of the existing OS. This provides performance but does not have the restriction of only being to create guests with the same OS type as the host. Also, VHM is *__not__* a hypervisor. However, many vendors use this term to describe their product. Some observers believe that relying on an uncontrolled entity such as a third-party kernel is not a good thing as it puts the future of the VHM in the hands of the OS kernel it is loaded into.

### Advantages:

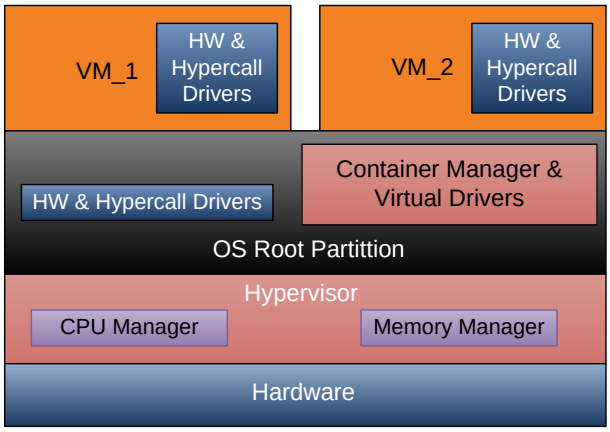
- Performance

### Disadvantages:

- Requires the underlying processor have virtualization extensions (examples: Intel-VT, AMD-V) to function.
- Older hardware that could otherwise be utilized by other virtualization architectures cannot be used.

Products include Xen-enabled Linux.

**UNCLASSIFIED PRODUCT**




The newly released Microsoft Hyper-V virtualization product employs elements of both the Bare-Metal and Hybrid architectures. Specifically, there are both kernel-level drivers (hybrid) and a hypervisor with VM containers (base-metal). Since this product requires CPU virtualization extensions, we feel this is more a hybrid architecture product than a bare-metal product. However, Microsoft positions Hyper-V as a competitor of VMWare ESX.

## HOW TO THINK ABOUT VIRTUALIZATION

Everyone (including consultants like us), would like a quick "Consumer Reports" answer. As with most business IT issues, the correct answer is "It Depends". The first step is to Succinctly Define Your Needs. This can be a challenge if virtualization has not been experienced. A VMWare executive describes the VMWare Customers experience in these terms:

> **Stage 1:** Separating Hardware and Software: Here multiple copies of a working software configuration are built that can be cloned and maintained in a library. Typically workstation but also servers are built. Windows and Linux are run on the same computer. Test and development for any possible hardware/software configuration is undertaken.
>
> **Stage 2:** Server consolidation: Users realize they don't have to run just one application per server anymore. The server can run up to 80 to 85 percent CPU utilization on a VM instead of running at 5 to 15 percent. Soon operational requirements and redundancy issues lead to the need/want to move software (VM) around dynamically across physical boundaries (multiple physical servers).
>
> **Stage 3:** Resource Aggregation: Here hardware resources (CPUs, RAM (memory), disks, and other resources) are brought together to get even better utilization. This can be done dynamically permitting IT staff to service equipment when broken without any service interruption. Resources are dynamically allocated adding capacity when needed to maintain response time, and provide high availability because resources are pooled.

**Stage 4:** Automation and Management: Now it is realized that how software runs can be managed and automated. Examples:

- Software can be grouped together and treated as a unit for testing and development.
- Software lifecycle management can be automated.
- How an application or a set of applications go through disaster recovery can be an automated/scripted process that takes advantage of VMs instead of in a DR playbook and can be tested in the production environment.

**Stage 5:** Liberation. Here multiple data centers are treated as a cloud because the VMs can move around. In this way external data centers, hosting providers, and cloud providers all can be used. VMs both on-premise and off-premise are secured and monitored.

Compare your needs (don't overlook VM management) against vendor models, offerings and strategies.

## VENDOR STRATEGY

### Citrix and XenSource

> *"We want a strong ecosystem. We want to enable choice."*
> Simon Crosby, CTO Virtualization and Management Division, Citrix (former CTO of XenSource)

According to this thinking, virtualization is a commodity technology expected to adhere to public standards. Value is in how Citrix/XenSource can deliver an application, regardless of what the system requirements are, that makes both the operational and end user experience better.

### Microsoft

> *"Virtualization is like TCP/IP. It's a means to an end."*
> David Greschler, Directory of Integrated Virtualization Strategy, Microsoft

Microsoft sees virtualization as just another hardware control/interface that is traditionally an OS function. The infrastructure doesn't matter just the management. Consequentially these virtualization technologies, although proprietary or having proprietary components, are still a commodity "given away" and implemented as part of the OS. Hypervisor products such as Virtual PC, Virtual Server, and the unclassified Hyper-V are all free. Management is provided by tightly integrated software product such as Microsoft System Center.

### VMware

> *"Being able to virtualize everything is the number one thing that drives VMware."*
> Raghu Raghuram, Vice President, VMware Products and Solutions

For VMware virtualization technology is the centerpiece. The goal is to fully abstract the technical environment so that all VMs only see the view that VMware gives them. Currently, even network devices such as switches are virtualized. Success would mean achieving the condition where any unit of capacity is genuinely interchangeable with any other unit of capacity, regardless of the physical world that surrounds it.

## OUR TAKE

We think virtualization is very powerful – but at a cost. It isn't for everybody.

1. Virtualization requires significant physical hardware resources. Published Intel studies indicate that 1.5 CPU cores per VM are needed for efficient processing. This means a quad-core CPU supports a maximum of 2 VMs, not including host requirements. Adding CPUs dramatically increases computer costs. Don't forget RAM requirements. Three VM's with 1GB RAM each need at least 3GB of physical RAM. A 32 bit OS can only address about 4GB of RAM. Virtual machines are also subject to this limit. Consequentially some virtualization solutions, such as Microsoft's Hyper-V, require 64 bit hardware.

   We have found VM's running in the Hosted model on a reasonably well equipped workstation (3Ghz Dual-Core CPU with 4GB RAM) platform to be very slow. Response is too slow for use as production machines. We believe this is one reason VMWare ESX offerings dominate Enterprise Data Center virtualization. Employing the Bare-Metal model virtualization model provides performance.

2. For all its power, sophistication and usefulness, in the end virtualization and the VMs rely on the physical computers on which they are installed. In a virtual world with several VMs, if you lose the physical hardware, you lose the entire virtual world. If those VM's perform tasks that are critical to business, then a second set of physical assets are strongly recommended.

3. Management challenges are increased including the social issues surrounding policy compliance. VM related management tools are important, perhaps a critical aspect of the virtualization model/vendor decision. We feel that businesses should have their IT and Business processes aligned, Service Level Agreements settled and Fair Use, Security and Control Policies implemented before considering virtualization. While all aspire to this goal, many organizations fall short. The power of virtualization magnifies weaknesses in these areas.

   It is very easy to create VM's and very hard to know how many VMs you have, where they are, what's in them, what state they are in, and who is acting on them. Because there is no obvious capital purchase required for a new VM, there is no obvious management approval process to create one. Imagine the nightmare of managing workstations and servers that can be created essentially at no or low initial cost possibly by unknowledgeable users who create unsecure and unstable network configurations. Add to the situation that there are only files, no physical machines. No one can know how many VM computers are present by simply walking around, looking and counting. It is not just malicious employees who might create rogue VMs. Mid or first level supervisors might be under performance pressure creating additional VMs "just to get over the hump". It would not be possible to do this if they had to go through purchasing to buy computer equipment. Businesses must be very disciplined in creation of VMs or capacity will become an issue impacting performance.

4. Licensing Compliance. Just because the computer is a Virtual Machine does not relieve the owner from the legal requirement to honor software licensing agreements. Remember, Licensing responsibility is yours. If you don't have a special license agreement, cloning a VM with installed software requires purchase of additional license, and possibly a change of key codes on each cloned VM.

   **Final Thought**: For organizations running a Small Business Server, we think virtualization of a Server in business production environment is not appropriate.

**"What's the best virtualization solution?"**

It depends.

It depends on what you value the most in a solution.

It depends on what you need to address in your own data center.

It depends on what you need out of a virtualization technology today.

It depends on what you need out of a virtualization technology tomorrow.

It depends on what you expect from a management perspective.

It depends on what you need out of vertically-focused virtualization solutions.

It all depends.

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