The 2011 Focus Experts' Guide to Server Virtualization

Focus Research
January 2011

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Section 1: Introduction

Virtualization – of servers, applications, client systems, storage and networks – has been one of the hottest topics in IT for the past several years. Adoption of server virtualization has reached over 90% of organizations overall, with early adoption coming from enterprise organizations, and more recent adoption becoming widespread in smaller businesses.

Server virtualization is a top priority for mid-size businesses in 2011. Server virtualization offers immediate benefits to organizations of all sizes, although the benefits may differ between large and small. This Focus Expert's Guide will help you to understand what server virtualization is, where it fits in the overall virtualization landscape, how to determine if and how it can help your business, and how to choose the best solution for your specific needs. This guide includes the following sections:

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Section 2: Meet the Expert

The Focus Expert Network community includes more than 5,000 business experts participating in Q&A, research and events at Focus.com. Focus.com's content and community is free and available to all.

The analysis and recommendations in this Guide were developed by Barb Goldworm, a Focus Expert Adviser on virtualization. The Guide is based on the extensive virtualization research and analysis of FOCUS, LLC (www.focusonsystems.com), where Barb is president and chief analyst. FOCUS LLC is a partner organization in the Focus Expert Network.

Focus.com Expert Adviser: Barb Goldworm

Barb Goldworm is a well-known industry expert, frequent keynote speaker, author, analyst and columnist on virtualization, systems management, storage and cloud computing. Barb is founder, president, and chief analyst of FOCUS, LLC, a research analyst and consulting firm, founded in 2000, focused on virtualization, systems and storage.

Barb has over 30 years' experience in senior management, technical, marketing, sales and industry analyst positions with IBM, StorageTek, Novell, Enterprise Management Associates and other successful startup ventures. In addition to giving regular keynotes at hundreds of virtualization, datacenter and storage events throughout North America, Barb is the Virtualization Track Chair for *Interop,* responsible for all the virtualization track sessions as well as the highly acclaimed in-depth virtualization workshops. She is also virtualization chair for *COMDEXVirtual*, chair of *DataCenter Insights*, and is on the advisory board for *CloudConnect.* She also created and chaired the Storage Networking Track at *Interop* and chaired the *Server Blade Summit* on Virtualization and Blades. Barb has also been one of the top rated expert speakers at *Tech Target Data Center Decisions, and Storage Decisions,* as well as at *Storage Networking World.* She has also been a regular speaker on webcasts and podcasts for *Information Week, Ziff-Davis, Tech Target* as well as numerous industry leading vendors.

Barb has published extensively since the 1990s, writing regular expert columns for publications including *NetworkWorld, Computerworld Storage Networking World Online*, *Tech Target SearchServerVirtualization, SearchVMware, SearchSystemsChannel, Virtual Strategy Magazine* and others.She serves on multiple advisory boards and has been a judge for various awards such as Best of VMworld, and Product of the Year. She has published hundreds of articles, business and technical white papers and market research reports, as well as the book *Blade Servers and Virtualization*, published by Wiley. Barb can be reach at barbgoldworm@focusonsystems.com.

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Section 3: Essentials

What is Server Virtualization?

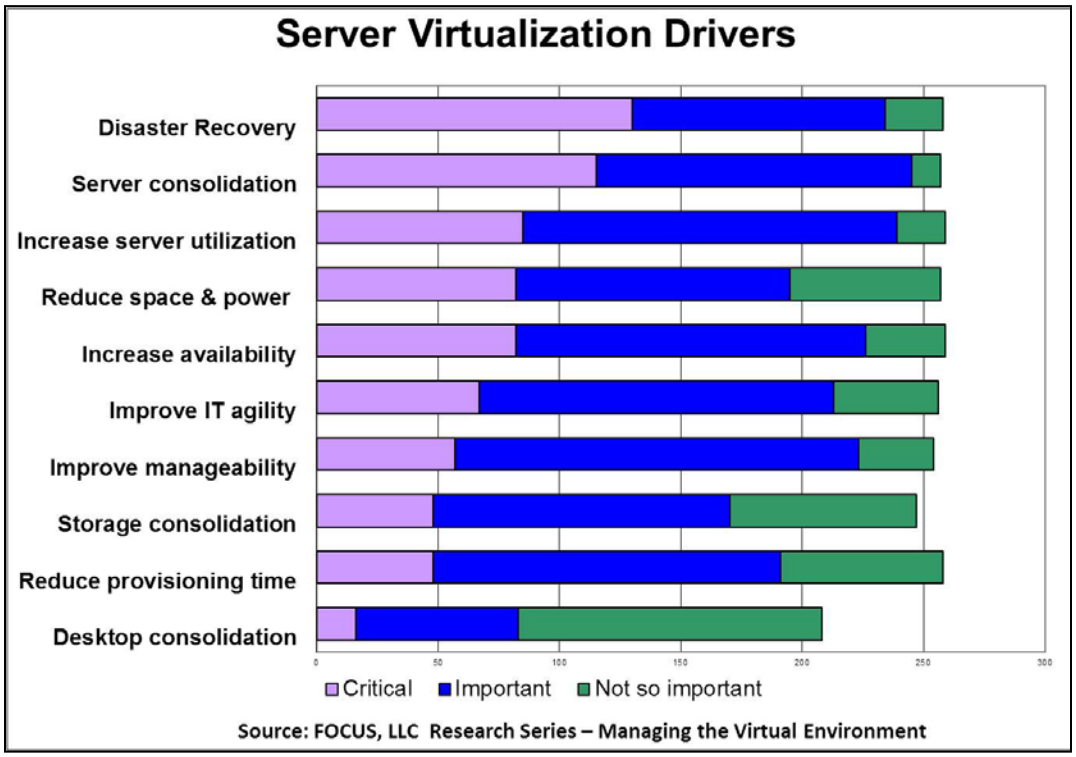
Virtualization is defined as an abstraction or separation of compute resources away from the hardware or software layer running below them. Virtualization can be implemented at many layers of the computing "stack" and across different computing resources, including servers, desktops, applications, storage, and networking. Server virtualization, the focus of this Guide, is abstracting the computing operating system away from the underlying server hardware.

The virtualization software layer that runs on the server hardware is called a Virtual Machine Manager (VMM) or hypervisor. It manages all of the hardware resources and creates a platform on which individual Virtual Machines (VMs) can be run. Each VM "looks and feels" like a complete, separate copy of the operating system to the applications being run and to the users of those applications.

Server Virtualization: The Top Reasons Why Businesses Buy

Company needs driving server virtualization can be divided into two main categories, consolidation and disaster recovery (DR). Based on Research Conducted by FOCUS, LLC on "Managing the Virtual Environment," consolidation was the initial reason for most early adopter organizations to virtualize. More recently, however, DR has become a significant driver as well. (See Figure 1.)

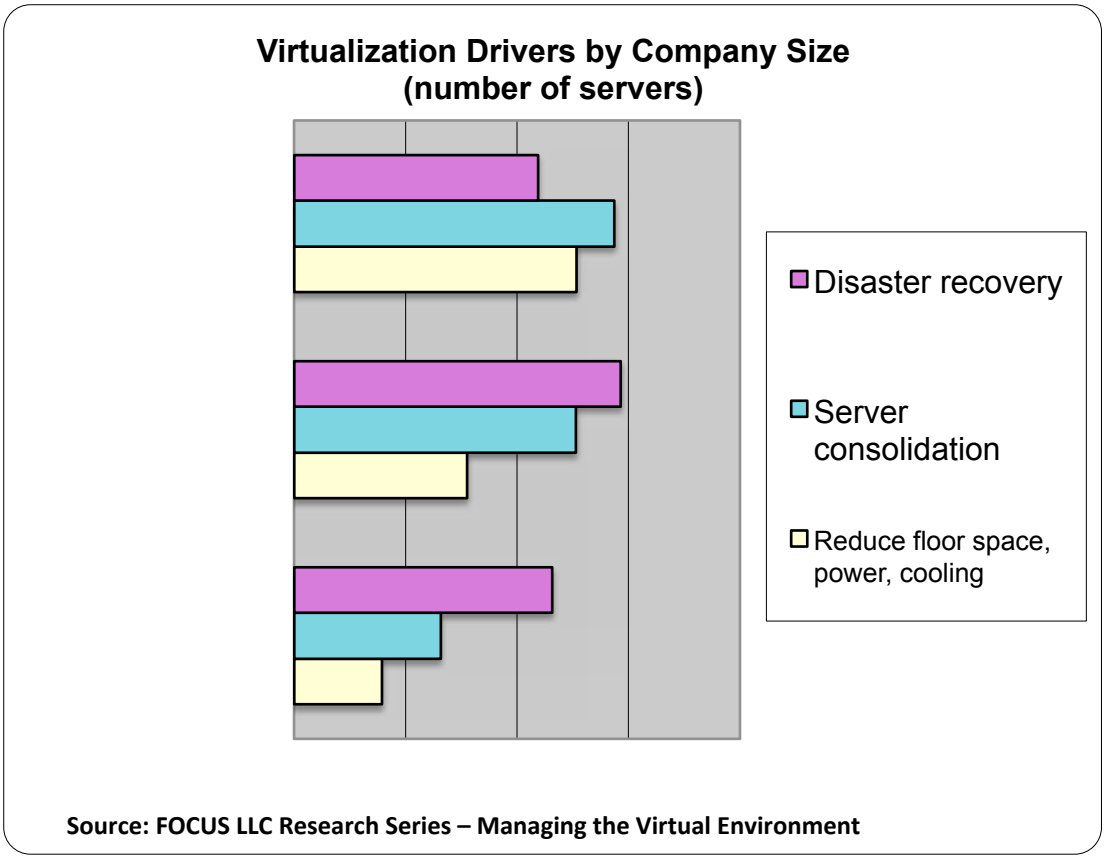
Figure 1. Drivers of Server Virtualization



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This shift in top drivers for server virtualization is also likely due to more SMB organizations now virtualizing, since consolidation is less of an issue for those with fewer servers, whereas DR has become more critical for organizations of all sizes. This is reflected in Figure 2, showing a breakdown of drivers by size of organization.

Figure 2. Virtualization Drivers by Company Size



Source: FOCUS LLC Research Series – Managing the Virtual Environment

Server Consolidation

Server virtualization initially gained its significant market momentum largely due to the huge benefits it delivered through server consolidation. Most physical servers run at utilization rates of 10 percent or less. Taking server workloads, running them as VMs and consolidating multiple VMs onto a single physical server can reduce the number of servers needed to deliver the same total computing power. This reduces the number of servers, as well as the space, power and cooling required.

Consolidation offers dramatic cost savings, reducing the total cost of ownership (TCO) for that total workload, and providing an excellent ROI. For example, for an organization with 10 to even 60 or more servers, the same aggregate workload might be supported using only two servers, running 10-60 or more VMs. (A minimum of two servers is always still recommended for redundancy and availability.) The consolidation ratio is highly dependent on workload, the physical characteristics of the server, and the hypervisor performance.

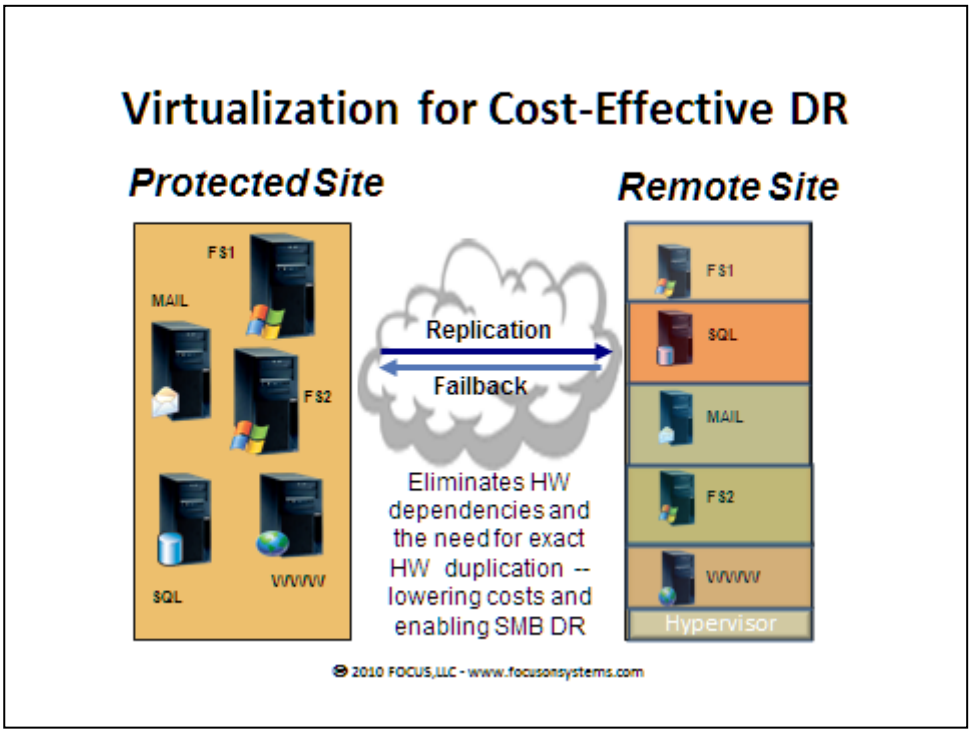
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Disaster Recovery (DR)

Independent of consolidation, virtualization is also an enabler for very cost-effective disaster recovery or DR. Traditionally, DR has involved creating a secondary site which exactly duplicated the hardware in the primary site, and which could be "brought live" in the event of a disaster. Because of the high cost of duplicating all the hardware, many SMB and SME organizations had never been able to afford the expense of a DR site.

With virtualization, a secondary site can be built with a minimal number of physical servers, running all the server workloads as VMs. In some cases, the primary site is virtualized as well, to keep both sites identical, but DR can be accomplished by virtualizing only the secondary site, if so desired. Using virtualization this way has allowed many SMB/SME organizations to have effective DR strategies and functional DR sites for the first time ever, due to the dramatically reduced costs. (See Figure 3.)

Figure 3. Virtualization for Cost Effective DR



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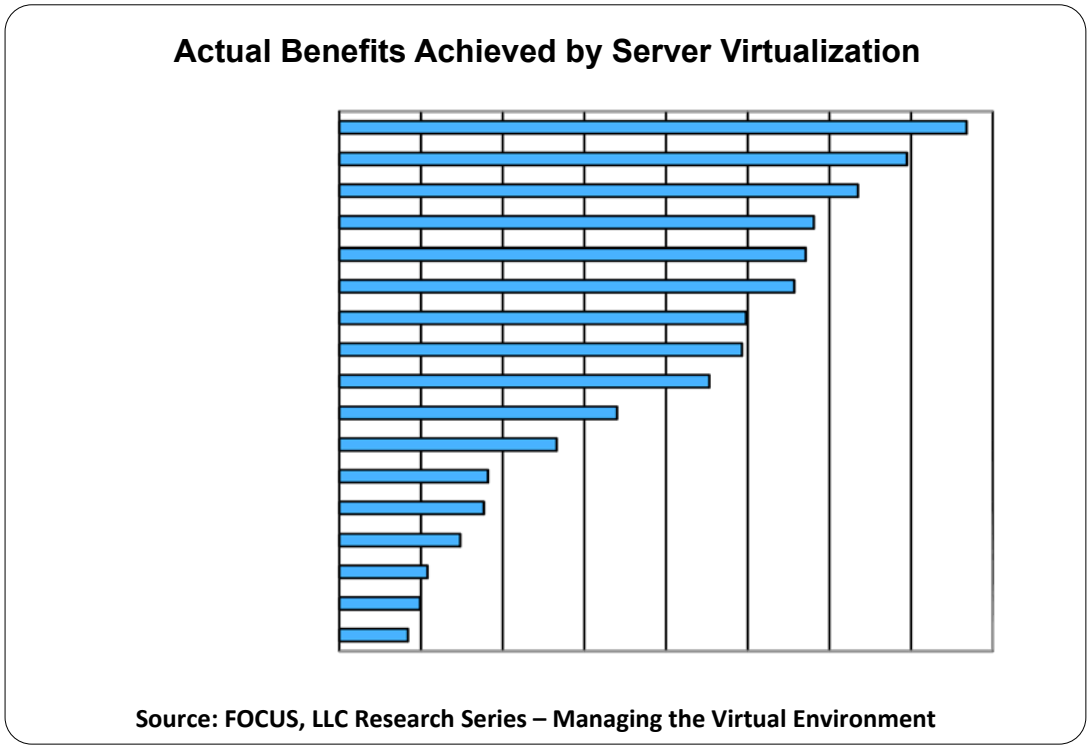
Server Virtualization: Benefits Achieved

Server virtualization is one of those rare IT solutions that has actually delivered on its promise. According to users who have implemented virtualization,the actual benefits achieved match those described in the marketing literature, including:

- increased utilization of resources;
- reduced space, power and cooling;
- reduced TCO and increased ROI of servers;
- improved IT agility and reduced provisioning time; and
- improved disaster recovery and availability.

See Figure 4 for actual percentages of users listing these benefits.

Figure 4. Actual Benefits Achieved by Server Virtualization



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Server Virtualization: What Type of Buyer Are You?

For the purposes of using this Guide, your Buyer Type is determined primarily by your stage of virtualization, and the size of your immediate IT responsibility.

You are a **Basic Buyer** of server virtualization if your company:

- has not yet implemented server virtualization anywhere in your organization;
- has server virtualization implemented somewhere in the organization but your group's needs are different; and/or
- has fewer than 25 servers in your area of responsibility.

In contrast, you are an **Advanced Buyer** of server virtualization if your company:

- is already using one or more server virtualization solutions in production somewhere in your organization;
- has requirements for advanced management capabilities; and/or
- is also evaluating desktop virtualization for more than 100 desktops.

Following are 10 things you should know before starting your evaluation of server virtualization.

Server Virtualization: 10 Things You Need to Know

1. **It's not just for large enterprises.** Although most early adopters were large organizations looking to consolidate, there are many benefits for smaller organizations as well. See #2 below.
2. **It's not just for consolidation.** While there are big benefits from consolidation through virtualization, they are not the only benefits. Improved disaster recovery, increased availability (for preventive maintenance, rolling software upgrades as well an unplanned outages), faster provisioning of new servers and applications through VMs, and dynamic workload management are also huge benefits that drive smaller organizations to virtualize, even if consolidation is not a big issue.
3. **It should be viewed as part of an overall virtual infrastructure.** This means that storage and networking should be a key part of your evaluation and ongoing management process. The real long-term benefits of virtualization come from the agility and dynamic aspects of a virtual infrastructure, and that agility involves dynamic management across servers, networking and storage. Optimizing and potentially virtualizing the overall infrastructure is key to reaping those long-term benefits.
4. **It's a key enabler for private/public/hybrid cloud.** This means that as the market and your organization move further towards cloud computing, virtualization will play a pivotal role. As a result, if you are thinking about cloud computing, you should look at server virtualization and cloud as closely related, and make your decisions accordingly.
5. **Management is critical to achieve the full benefits.** The initial benefits of consolidation come immediately upon reducing the number of physical servers (and thus the space, power and cooling required). The full benefits already discussed require the right management tools and processes to support a dynamic IT infrastructure, from the applications down through the virtual and physical infrastructure.

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6. **Virtualization and the vendor landscape are changing constantly.** While the server virtualization market is fairly mature in terms of the hypervisors themselves, the management solutions and the overall virtualization ecosystem are still changing constantly. New products and vendors are still emerging weekly, and startups are being acquired by the big players almost as fast. In addition, the early management tools that were developed for one hypervisor (typically VMware) are now being expanded to support multiple hypervisors, generally with support for Microsoft's Hyper-V coming next, followed by Citrix XenServer.
7. **Consider your desktop plans as part of your decision process.** Although server virtualization got all the early press, desktop virtualization (which actually came first) is the newest virtualization buzz. Client-based desktop virtualization started with VMware Workstation (VMware's first product more than 10 years ago) and has a substantial user base. Microsoft's Virtual PC also had an early following, but both offerings were niche plays for development and testing of multiple configurations by developers. Today, server-hosted desktop virtualization including Virtual Desktop Infrastructure (VDI) is a hot area for enterprises and higher-end mid-market organizations. All of the major server virtualization vendors also have VDI offerings; however, some of the offerings also will run on other vendors' hypervisors.
   This is a complex area, and beyond the scope of this Guide. But if you are considering any flavors of desktop virtualization, we recommend that your evaluation process for both server and desktop virtualization be linked together.
8. **Get help from those with experience.** If you are just starting out, you need to know that the road to virtualization still has a lot of potholes. Getting help from those who have already driven down this road can make for a much smoother ride. If you have a good relationship with a trusted provider or providers, start by finding out what vendor offerings they have and what expertise they have. Getting help from a provider you trust, and that has proven experience with the vendor/solution you choose can make a big difference in your speed of implementation and minimize the bumps in the road.
9. **Start with the low-hanging fruit.** Most organizations have had great success in the early low-hanging fruit of server virtualization. Pick a single project to begin with, and look for the easy-to-virtualize servers/applications such as file servers, print servers, and Web servers. Business-critical applications have additional requirements that can perhaps be met as part of your initial efforts. However they will require additional management tools for performance management, troubleshooting from the application down through the virtual and physical infrastructure, etc.
10. **Think strategically even as you act tactically.** All of the available solutions will do the job of basic consolidation and even basic disaster recovery. The real benefits and the real challenges come in shifting the paradigm to a virtual infrastructure and moving towards a dynamic and agile IT environment. Knowing where you want to go, especially relative to cloud computing and desktop and application delivery, will steer you toward the right virtual foundation for the future. Then based on that strategy, you can take the tactical steps to get there.

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Section 4: The Market

Overview

The x86 server virtualization market has had more than 10 years to mature. (For a history of this market maturation and the main players that emerged, see Appendix A.) Today there are multiple viable options for business of all sizes and all types of buyers. Server virtualization is now considered mainstream technology and according to most analysts has been adopted by more than 90 percent of IT organizations, with roughly 25 percent of all servers virtualized to date.

Virtualization has become a foundation for transforming and modernizing the IT infrastructure, delivering not only consolidation benefits and increased resource utilization, but also DR, improved availability, faster provisioning, and overall improved IT agility and responsiveness. It is also a key enabler for cloud computing. Virtualization is equally critical for IT organizations building private clouds, for cloud service providers delivering Infrastructure as a Service and, over time, for the combination of the two into hybrid clouds.

Key Market Trends

1. The server virtualization market has matured to the point where the hypervisor has become largely commoditized.
   Today the basic virtualization functionality is similar across hypervisors (for more detail on the definitions and types of hypervisors, see Appendix A). VMware, Microsoft and Citrix hypervisor offerings all perform the basic required functions, with some variations in performance and integration with other software. The biggest differences are now in the management stack above the hypervisor.

2. Server virtualization has achieved widespread market adoption in terms of the number of companies but still has a long way to go towards 100% virtual environments in those companies (if ever).
   According to the latest FOCUS, LLC Research, 90 percent of organizations have implemented server virtualization to some extent, but estimates are that only 25-30 percent of servers overall are running virtualized. Early adopters tended to be larger enterprises, which virtualized their low-hanging fruit, then ran into challenges (often called "VM stall") as they tried to expand beyond 25-30 percent. Moving to the next phase requires a focus on optimization, automation and advanced virtualization management, essentially resulting in the move towards private cloud. (More on private cloud below.)

   Virtualization has exploded among SMB/SME organizations during the past few years, and those organizations typically move much more quickly once they start. These smaller organizations tend to be more homogeneous and less political than large enterprises, and so can move more quickly in virtualizing their server mixes. While they may not become completely virtualized environments since there are still some applications that don't virtualize well, SMB/SMEs tend to get to levels of 80 or 90 percent virtualized quickly.

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3. Virtualization has transitioned from small pilots run by techy geeks to strategic IT initiatives and 'Virtual First" policies.
   The early days of server virtualization were experiments in labs. These were often run by techies who started with VMware Workstation for dev/test and then moved on to server virtualization because it was "cool." The next wave expanded to consolidation projects, especially for data centers that were out of physical space or power but needed to add server capacity. Because of the tremendous success in consolidation, virtualization became mainstream, and has now been implemented widely for consolidation. In addition, in many organizations, virtualization has become so successful that IT management has implemented a policy known as "Virtual First." Under such a policy any new server that is required is created as a virtual server, unless there is some technical reason not to do so.

4. Virtualization is the foundation for private cloud computing.
   Virtualization has evolved in the marketplace from a platform for consolidation to a strategic platform for a new and better way for IT to do its job. The benefits of increased availability, rapid provisioning, and dynamic workload management have started a paradigm shift in IT. Virtualization has become the enabling foundation for delivering what has been called Dynamic IT, autonomic computing, utility computing, IT as a Service, or most recently Private Cloud Computing.

   Cloud computing has many definitions to many different people, and it is outside the scope of this Guide to enter that entire debate. Private cloud computing can be defined as the use of virtualization and other dynamic technologies to allow services on an internal (in-house) IT infrastructure to be delivered as a utility. Examples of other relevant technologies include policy-based management, self-service provisioning and usage-based accounting Because private cloud is so closely tied to virtualization, it is important to understand the path from server virtualization to private cloud. For more information on the steps in this path, see Appendix B.

Vendor Landscape

As stated previously, the hypervisor market has matured, with the key dominant players being VMware, Microsoft and Citrix, along with the Xen open-source-based hypervisor community. The management ecosystem for virtualization is a huge and rapidly changing landscape, with hundreds of players, ranging from startups, to traditional IT management vendors, and including the virtualization hypervisor vendors themselves.

This Guide examines the vendor landscape as it pertains to the hypervisor only. While it will discuss some of the management issues, the focus will be on a process to be used for evaluating the base server virtualization solutions and their basic management tools.

The current list of key vendors deliveringx86 server virtualization hypervisor functionality includes:

- Citrix Systems, Inc.
- Microsoft
- Novell
- Oracle
- Parallels
- Red Hat, Inc.
- VMware, Inc.

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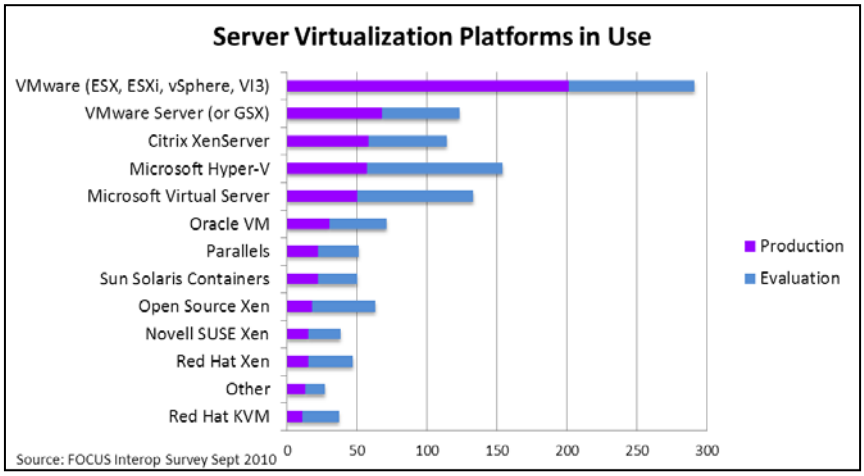
VMware continues to dominate the server virtualization space in terms of market share, with most enterprise organizations running VMware ESX, ESXi, VI3 and/or vSphere. Recent changes in the landscape involve a growth in both Microsoft and Citrix, coming from two areas:

1. New organizations, typically SMB/SME companies, who have not yet virtualized, now have an easier path to virtualization. For pure Windows shops, with Hyper-V now being a free part of Windows Server 2008, virtualizing with Windows alone eliminates a steep part of the learning curve, not to mention the cost curve. For SMB organizations with both Windows and Linux, XenServer also offers a free option, with a relatively simple implementation.

2. A growing number of large organizations who started with VMware are now adding multiple platforms into their IT infrastructure in addition to VMware. These additions typically come from one or more of the following.
    a. **Rollouts of MS Windows Server 2008 R2, which includes Hyper-V.** As organizations migrate to the latest version of Windows Server, it is basically a "no-brainer" to at least look at Hyper-V, now that it is a viable enterprise-class product.
    b. **Implementations of Citrix farms** (running Citrix XenApp/Presentation Server). Although XenApp will run on VMware, it has additional integration advantages running on XenServer (which is also free).
    c. **Pockets of open source projects** within the organization, implementing Xen-based virtualization, including Citrix or others
    d. **Oracle databases**, which will also run on VMware, but in order to get full official support from Oracle were supposed to run on Oracle VM. (There have been recent changes in late 2010 which have relaxed this Oracle policy.)

Figure 5 shows server virtualization platforms in use, including both Type 1 and Type 2 hypervisors (see Appendix A for definitions of Type 1 and Type 2 hypervisors). Type 2 hypervisors are mostly installed from previous projects, and most organizations are migrating to Type 1 hypervisors (e.g. MS Virtual Server to Hyper-V, and VMware Server to ESX). However, there are some ongoing evaluations of Type 2 hypervisors, generally in smaller organizations expanding previous projects, with limited time and money, and because these products are free. Overall, Type 2 hypervisors are not recommended for future production deployments due to performance overhead.

Figure 5. Server Virtualization Platforms in Use



Section 5: Your Needs and Product Requirements

Given that there are multiple mature and viable hypervisor solutions now available, choosing between them should be based on matching their strengths to your prioritized needs. Basic Buyers and Advanced Buyers share some of the same needs, but will differ in several key areas. They will often prioritize their needs differently as well. Understanding your requirements and priorities will be key to making the best choices.

Knowing Your Requirements

Although requirements and priorities will vary from one organization to another, there are many similarities based on Buyer Type, as described previously in Section 3. These types are characterized generally by organization size (number of servers), virtualization solutions already in use (in evaluation, pilot, or production), and advanced management requirements.

You are a **Basic Buyer** of server virtualization if your company:

- has not yet implemented server virtualization anywhere in your organization;
- has server virtualization implemented somewhere in the organization but your group's needs are different; and/or
- has fewer than 25 servers in your area of responsibility.

You are an **Advanced Buyer** of server virtualization if your company:

- is already using one or more server virtualization solutions in production somewhere in your organization;
- has requirements for advanced management capabilities; and/or
- is also evaluating desktop virtualization for more than 100 desktops.

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The following chart can serve as a starting point to identify your key requirements and priorities, and compare them against the available solutions. The chart is grouped into several key areas, with specific features to consider in each area and comments on the features overall, and their relationship to different buyer types and organization sizes.

Figure 6. Requirements for Different Buyer Types

FEATURES	BASIC BUYER	ADVANCED BUYER	ADDITIONAL
Virtual and Physical resource requirements	Basic support for your current environment	Support for your environment plus other groups within your organization	This group of requirements is based on your needs for supporting both virtual resources and hardware support requirements
Guest OS support	Often Windows only	Multiple OS types, e.g., Windows, Linux, Mac	
32- or 64-bit support	Depends on OS versions	Depends on OS versions	64-bit support is required for newer OS versions to allow more memory. Older versions will require 32-bit support as well
Virtualization HW assist requirements	May need the ability to run on older hardware to keep costs down, which may eliminate certain choices (see comments)	May want support for older hardware due to large inventory of older machines, which may eliminate certain choices (see comments)	If there is a need to run on older (Pre Intel-VT or AMD-V) hardware, this will eliminate hypervisor choices requiring these virtualization assists
# of CPU cores and maximum RAM supported (host and guest)	Dependent on available hardware and performance requirements	Dependent on available hardware and performance requirements	
Support for virtual processors.	Dependent on applications	Dependent on applications	
# of VMs per server (workload dependent, server dependent and overhead dependent)	May not be a big factor if only a small number of servers within the organization	Can have significant effect on cost savings due to consolidation ratios	Most important when consolidation ratio is important

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FEATURES	BASIC BUYER	ADVANCED BUYER	ADDITIONAL COMMENTS
Management Features	Basic buyers generally require basic management only, often included with the hypervisor	Management features for advanced buyers are key to fully realizing long term ROI and TCO benefits	Basic virtualization requires only limited management functionality included with the hypervisors. Advanced management typically requires additional management tools from hypervisor vendors and/or 3rd parties.
Live Migration capabilities	Basic management allows migration for currently running VMs	Advanced mgmt. may also add ability to migrate running VMs locally, and over distance, as well as migrating storage of running VMs	Management feature key to workload movement for increased availability, workload balancing and preventive maintenance
Memory overcommit/ dynamic memory/ memory optimization	These various advanced memory techniques help increase the consolidation ratio, and may be important when consolidation is a key driver for virtualization	These various advanced memory techniques help increase the consolidation ratio, and may be important when consolidation is a key driver for virtualization	
Hot add of resources (virtual disk, memory, CPU)	Typically only needed for more advanced management	Helpful for dynamic workload management	
Role-based administration/ management	Not an issue here generally because the organization isn't that large	Allows different admins to be authorized to manage different users or specific functions	
Disaster Recovery features and automation	Snapshots and possibly replication	Automation through Site Recovery tools	Basic capabilities provided through snapshots and replication, with advanced automation capabilities through Site Recovery tools
High Availability (HA)	Automatic Failover - For applications that require minimal downtime.	Failover is typically configured for a significant number of applications (outside of dev/test)	HA can be provided through HA features for VMware (VMware HA) or XenServer (XenHA), while Hyper-V leverages Windows Server 2008 failover clustering and VMM
Fault tolerance	Only if there is a very critical application	Generally for top tier of mission critical applications	
Advanced (distributed) virtual switch capabilities	Not a big issue for small number of servers	Highly valuable for large number of physical servers within the virtual cluster	

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FEATURES	BASIC BUYER	ADVANCED BUYER	ADDITIONAL COMMENTS
Management Features (continued)			
Automated workload balancing and scheduling	Not required in smaller and static environments	Automated workload management tied into policy becomes critical for self-managing autonomic infrastructure on the road to private cloud	
Policy-based management	Often not implemented in smaller and static environments	Important to build policies early on, and have those policies in place to avoid problems with virtual sprawl	
Provisioning tools (templates, linked clones, provisioning services (OS streaming)	For small and static environments these tools are less critical	Tools to simplify and automate provisioning become key as virtual environment grows (server and desktop VMs). Ability to minimize disk requirements through smarter provisioning services and shared images is also important for larger growth shops	Templates are available in various forms across all products. Linked clones are part of VMware View (for VDI). Provisioning Services are a unique feature which is part of Citrix XenServer and XenDesktop and offer OS streaming to virtual and physical devices.
Self-service provisioning	Generally not implemented in smaller environments	Key part of the road to private cloud	Allows IT to set policies and gives a portal to users so that they can provision their own VMs and services, while adhering to the polices set by IT
Lifecycle management tools	Not as critical for small and static environments	Essential for preventing VM sprawl in larger organizations with larger numbers of VMs (server or desktop)	Available for various hypervisor environments as part of certain editions (XenServer), as separate products for server virtualization or cloud management (VMware LifeCycle Manager and vCloud Manger) or in general management solutions (Systems Center Suite)
Management APIs	Typically managed with tools included with base hypervisor	For integration with existing management tools used in the enterprise	

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FEATURES	BASIC BUYER	ADVANCED BUYER	ADDITIONAL COMMENTS
Management Features (continued)			
Availability of 3rd party management tools	Typically managed with tools included with base hypervisor	Important for many of the advanced capabilities, and for multi-hypervisor environments	VMware ecosystem is most advanced currently, but growing fast for MS as many startups add Hyper-V support to their originally VMware-only products. Some availability through open source products for Xen as well.
Management of virtual and physical resources	Using one tool for virtual and physical servers (like MS Systems Center) may help simplify management for basic buyers	Integration between virtual management tools (e.g. vCenter) and physical management tools from your key hardware vendors may be important	
Management of other hypervisors	For single hypervisor shops, this is not an issue	For larger organizations, where multiple hypervisors are likely to occur, it is important to look at which tools manage which hypervisors	Although VMware tools manage only VMware environments, other vendor management tools manage multiple hypervisors (e.g. Systems Center VMM manages Hyper-V and ESX, and Citrix Essentials manages XenServer and Hyper-V)

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FEATURES	BASIC BUYER	ADVANCED BUYER	ADDITIONAL COMMENTS
Organizational issues			
Existing vendor relationships from other installed products	Most shops already are MS customers for Windows and Windows apps	Most are MS customers for Windows Possibly also Citrix customers for Presentation Server or XenApp	Many larger organizations may already have relationships with all of the major vendors, VMware for early server or workstation virtualization, MS for Windows, SQL and/or Exchange, and Citrix for early session virtualization
Licensing model (per processor, per server, free)	Dependent on configuration, can affect price.	Dependent on configuration, can affect price.	Licensing models vary by vendor and even by product, and can get fairly complex, affecting price in a big way. Cost comparisons must take this into account.
Skill Set required/available	Often have Windows skills only. May outsource advanced IT functions or systems administration	Often have Windows and Linux, both basic and advanced skills	Smaller Windows-only shops may find Hyper-V to be an easy path since it is so Windows-focused.
Future plans			
Cloud capabilities and interaction	Many smaller organizations are early adopters for public cloud, many of which are currently Xen based, although VMware is making a strong push here. MS is also making a big push around Azure for public cloud, which will become better connected with their Windows and Hyper-V strategy	VMware is making a major effort to connect their advanced virtualization management tools tightly integrated with cloud management. MS has recently announced their Hyper-V Cloud program for fast track private cloud building. Most public clouds today are open source Xen based.	All of the major virtualization vendors are pushing into the cloud, but from different perspectives and strengths. It will be important to think through your cloud strategy and consider how it should relate to your virtualization strategy.
Desktop virtualization plans	Many SMB organizations are considering Desktop as a Service which uses desktop virtualization over a public cloud. Others are looking at low-end desktop virtualization solutions which don't need advanced management capability such as that provided by MS VDI (which requires Hyper-V)	Organizations with large scale desktop requirements and a variety of use cases will be evaluating the broader desktop virtualization solutions such as Citrix XenDesktop (which runs on any of the big 3 hypervisors) or VMware View (which runs only on ESX)	Desktop virtualization may make sense even for basic buyers. If you are considering it, make sure to connect your plans with your server virtualization plans, as there are some that require a particular hypervisor.

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Section 6: How to Buy: Key Solution, Cost and Vendor Considerations

Solution Considerations

As shown in Section 5, there are many features to consider in selecting server virtualization solutions. Some of these features will play larger or smaller roles based on your dominant driver for virtualization. For example, if consolidation is you primary driver, then the features which increase consolidation ratios should be weighted heavily. If availability and disaster recovery are your primary drivers, then consolidation ratios are not important, but HA and management tools should be prioritized higher.

For many Basic Buyers, particularly those with very homogeneous environments, choosing one hypervisor that meets your requirements is both possible and optimal, to keep the management simplified.

However for Advanced Buyers, most organizations over time and across the organization are likely to end up with mixed hypervisor environments. In most of these cases, the early adopters within the organization most likely purchased VMware, and now pockets within the organization may be better served with other solutions, based on the types of issues already discussed. In these cases, certain new workloads will be virtualized on Hyper-V while existing workloads continue to stay on VMware, especially in cases where the VMware maintenance has already been paid. (This is subject to re-evaluation when maintenance contracts expire.)

Some organizations may choose to divide up by geographies. Other might choose different hypervisors by their application vendor affinity – e.g., MS SQL and Exchange being virtualized on Hyper-V, and Citrix XenApp being virtualized on XenServer. Other organizations continue to use VMware in the data center for their main data center infrastructure, and choose Hyper-V in branch offices where there is little to no IT expertise, or for special applications. In all these cases, these decisions should be carefully made, and should incorporate the considerations discussed in Section 5, and may also result in tiering different applications to run on different hypervisors based on costs.

Cost Considerations

Hypervisor costs have changed dramatically since the origins of x86 virtualization. As the hypervisor has become more commoditized, the price for the hypervisor itself has become basically zero for all of the three major vendors. VMware ESXi is VMware's free offering, Citrix offers a XenServer free edition, and Microsoft offers a free standalone Hyper-V or includes it in the Windows Server 2008 OS release.

However, even though the base hypervisor itself is free, there are still many costs to consider, and there has been much debate about which solution(s) cost less.

First, there are multiple editions of the hypervisors for both VMware and Xen, which are not free, which add features that may be essential for your environment. These are generally packaged into expanded versions such as Platinum Edition, Advanced, Enterprise or Enterprise Plus. Each vendor packages different management tools, and has different licensing models, which may even differ for base licenses versus management licenses.

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Consolidation ratios also may differ significantly between hypervisors, and may differ by workload. One vendor may do better for certain workloads than others. In addition, storage and management features differ by vendor, making the storage and management costs highly variable, and difficult to calculate. This has contributed to the cost debate, with each vendor claiming lower management costs for a given number of VMs, resulting in widely varying and hard-to-substantiate numbers.

The bottom line is this. The only way to truly know how the total costs compare for your environment is:

1. Select at all the features you require
2. Choose the corresponding packaging for your short list of solutions
3. Run pilot tests with your workloads (to estimate your consolidation ratios)
4. Estimate total pricing for your environment

And even with this approach, know that until you have some experience managing this new virtual infrastructure, it is difficult to assess the management costs (and savings of one solution over another, or even of the virtual environment versus the traditional physical one.

Pricing expectations

Depending on deployment, any of the options potentially can be more or less costly, but in general, VMware offers higher-end capabilities for higher end pricing. Microsoft offers basic function included in Windows, with the management functions priced separately through the System Center products, and shared across virtual and physical infrastructure. Citrix falls in between, offering XenServer for free, and charging for management products.

Here are some explanations of each vendor's pricing strategy, along with examples of current product pricing options. (All numbers based on list prices available publically from each vendor.)

VMware vSphere examples

Pricing for VMware is tiered and somewhat complicated, with separate pricing options for vSphere for different physical server characteristics, plus various bundles of additional management functionality, plus vCenter. The vSphere packages include Standard, Advanced, Enterprise, Enterprise Plus, and Enterprise Plus Cisco Nexus 1000v Bundle, with incremental features such as Data Recovery, Hot add, Fault Tolerance, vShield Zones, Storage VMotion, Dynamic Resource Scheduling, Dynamic Power Management, Distributed Switching, Host Profiles, Storage Multi-pathing, 8-way vSMP and Cisco Nexus 1000v.

Pricing starts at $795 for Standard Edition for 1 processor (up to 6 physical cores per CPU and 256 GB RAM) and goes up to $3,995 for Enterprise Plus Cisco Nexus for one processor, up to 12 physical cores per CPU, and no memory limit. Support and Subscription Services "SnS" services are also required, and are priced from $275 to $1,048 depending on the support level (Gold or Platinum) and the package/bundle.

In addition, pricing for most management functionality needs to include vCenter which is priced separately. Pricing for vCenter Server Foundation, which is limited to managing 3 Physical Servers, is $1,495, and vCenter Server Standard lists for $4,995. There are also SMB bundles designed for small IT environments with fewer than 20 physical servers, at a minimal up-front investment. These are priced at $879 for the Essentials Bundle for 3 Hosts and $2,995 for the Essentials Plus Bundle for 3 hosts. Additional management tools are also available, and are priced separately.

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Microsoft Hyper-V examples

Pricing for Hyper-V itself is either free (Hyper-V server) or included in all editions of Windows Server 2008. The licensing for WS2008 also includes the ability to run Windows VMs on Hyper-V, with Standard Edition allowing one VM, Enterprise Edition allowing up to 4 VMs, and Datacenter Edition allowing unlimited VMs on that server. (This Windows OS licensing applies to other hypervisor environments as well).

Additional management capabilities (such as live migration,clustered shared volumes, HA, physical-to-virtual ("P2V") and virtual-to-virtual ("V2V") conversion utilities, cross-hypervisor management for Hyper-V and ESX, automated provisioning and templates) are priced separately. These features are delivered through the Systems Center family, including Virtual Machine Manager for virtualization management, and optionally adding and interoperating with other Systems Center tools such as Configuration Manager (previously SMS) and Operations Manager (previously MOM), which many Windows shops may already be using.

Enterprise pricing for VMM is $869 and includes Virtual Machine Manager management server software and the Enterprise Management License. Pricing for midsize businesses is also available as Virtual Machine Manager 2008 R2 Workgroup Edition, for $40 and includes VMM management server software and the Client Management License. The VMM Self-Service Portal 2.0, which adds self-service provisioning, is available as a free download.

Citrix XenServer examples

Pricing for XenServer is a fairly straightforward tiered model. It starts with the free edition, which includes basic functions only, and moves up to the advanced edition ($1,000), Enterprise Edition ($2,500) and Platinum Edition ($5,000). The base functionality includes the hypervisor, live migration, VM snapshot, XenCenter distributed multi-server management, and conversion tools. The additional incremental features include HA, memory optimization, workload balancing, heterogeneous pools, power management, provisioning services, role-based administration, lifecycle management, and site recovery management.

Additional cost considerations

The costs and/or potential savings involved in virtualization can go well beyond the cost of the hypervisor and even the virtualization management software. Here are costs to consider including often hidden costs of virtualization:

1. Hypervisor itself
2. Hypervisor management
3. OS licenses – license fees for the servers or desktops to be run as VMs may be the same as your pre-virtualized licensing fees, but may be reduced. This is due to the unlimited VM license options in environments such as Windows Server 2008 Data Center Edition (which allows an unlimited number of WS2008 VMs to run under the physical server license). This Microsoft licensing option works for any hypervisor, not just Hyper-V.

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4. Shared storage – in order to take advantage of functions such as live migration, the host systems must have access to shared storage. If you don't have a shared storage infrastructure (FC SAN, iSCSI SAN, NAS, or virtual SAN software equivalent), you will need to create one to use advanced features. Even if you do, you will likely be increasing your storage costs as you move all your server storage from less expensive direct attached storage (DAS) to network storage (including your OS and application software images as well as data).
5. Training – The amount of training varies by hypervisor, with Hyper-V requiring the least, since it is mostly Windows, and VMware requiring the most, but also offering the largest toolset.

Total cost of ownership (TCO)

TCO can vary based on numerous factors, the least of which is the cost of the hypervisor. The bulk of the TCO capital expense ("CapEx") *savings* are likely to come from server consolidation, which is highly dependent on your consolidation ratio. If consolidation is your primary driver, then the reduction of servers and thus server costs should give you a substantial immediate reduction in TCO for CapEx, along with a reduction in space, power and cooling costs giving you an ongoing reduction in operating expenses ("OpEx").

As discussed already, the hypervisors are all available in free versions, and the bulk of the licensing costs for virtualization come from the management software. Likewise, the bulk of the software TCO comes from both the management software and the management soft costs. In other words, the TCO CapEx *costs* will come from the management software costs, and the TCO OpEx *costs/savings* will come from the ongoing costs and savings of managing the overall environment.

These costs vary based on the number of VMs an individual administrator can manage, also called the span of control. This is an area for much debate, with each vendor claiming their tools increase the span of control over their competitors. The discussions are also further complicated when taking into account the size of your organization as well as the skill sets within your IT group.

Return on Investment (ROI)

ROI is also highly dependent on the savings already discussed. If consolidation is a big part of your project, the ROI of your virtualization investment is fairly easy to show, since your results will cause a significant reduction in server hardware and associated costs. Consolidation typically increases server utilization from an industry average of 8 percent utilization for non-virtualized servers to 70-80 percent utilization for well-balanced multi-VM servers. Investing in virtualization with this type of return is the reason that server virtualization crossed into the mainstream initially.

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Vendor Considerations

Since the major hypervisor solutions available on the market are all from long-standing vendors in the industry, choosing one of these solutions has minimal risk in terms of vendor longevity. All the vendors have substantial customer bases in both the basic buyer and advanced buyer categories, ranging from SMB to enterprise organizations, and all are global organizations with worldwide support.

For deciding among the "Big Three" players, it is worth examining both your existing relationships as well as potential future relationships with each player:

Microsoft

1. Microsoft virtualization is clearly linked to Windows as well as its Windows-based applications and systems management. For "Windows-heavy" shops, this makes considering Microsoft a no-brainer. If you are using Systems Center management tools for other tasks, adding virtualization becomes just another piece to manage.
2. Microsoft is also investing heavily in cloud computing, with Azure and products like Office 365 for public cloud and Hyper-V Cloud programs for private cloud. There will be increasing connections between MS virtualization and cloud areas going forward, so it is worth considering any potential future plans in these areas as well.
3. Microsoft's strength in the PC desktop space is unequalled to date. The "desktop" is changing to include a broader definition, including mobile devices, tablets, SaaS applications and other resources. This evolution is causing some to question whether Microsoft will continue to dominate for the long term. Regardless, its presence in the desktop arena today and for the near term makes Microsoft a strong choice in desktop virtualization, both alone in the basic buyer space, and partnered with Citrix for the advanced buyer. If you are considering desktop virtualization as well as server virtualization, you need to take a strong look at Microsoft.

VMware

1. VMware is the player with the longest history in server virtualization, and as a result, has the broadest set of management tools. VMware also has a very satisfied customer base, with 190,000customersincluding all of the Fortune 100. For organizations looking to build highly advanced private cloud environments, VMware offers a great overall solution, with excellent and constantly improving performance, and a robust set of management tools for every aspect of server virtualization and private cloud management.
2. VMware has worked hard to grow beyond server virtualization, and has made major efforts in both desktop virtualization and public cloud. If these areas are also in your long term plans, your evaluation process should include at least an understanding of VMware's offerings and plans in these areas.
3. Advanced buyers almost certainly have VMware products installed somewhere within their organization. Choosing between continuing to virtualize exclusively with VMware versus supporting multiple hypervisors involves trade-offs. Managing multiple hypervisors will complicate the management process, but can reduce overall costs. In addition, adding other hypervisors for specific applications from those hypervisor vendors can offer specific benefits.

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Citrix

1. Citrix was the pioneer of what has been called server-based computing, now also called session or presentation virtualization, with its WinFrame, MetaFrame, and Presentation Services offerings. This product line has now been renamed XenApp and has more than 100 million users. Citrix has a solid understanding of how to deliver applications from a centralized server. The company has built on that strength to become the leader in the desktop virtualization space with its XenDesktop (including XenApp) product offerings. For current Citrix shops, XenServer offers a solid server virtualization platform that has been tuned for performance with other Citrix products. (Note also that XenDesktop and XenApp will also run on both VMware and Hyper-V as well.)
   Citrix also has had the most successful long-term relationship with Microsoft, going back fifteen years to Terminal Services, and now expanded to Remote Desktop Services, Hyper-V and Citrix Essentials. Citrix and Microsoft have allied themselves against their common competitor, VMware.
2. XenServer is the only offering of the big three that is open source based. Depending on your organization's perspective, this may be a good thing or a bad thing. In general, there are both pros and cons, mostly around pricing, ecosystem and the politics of open source.
3. Citrix has also pushed hard into the public cloud space. As of today, most of the public cloud is based on open source Xen technologies. Citrix is working hard to leverage this to its advantage and convert public cloud providers to XenServer. This would make XenServer an easy path for "cloudbursting" between on-premise virtualization and the public cloud.

Other vendors

For those organizations inclined towards alternative vendors, hoping for emerging innovation at lower costs, there are also options available from smaller players, such as Parallels, and open source Xen which offer alternatives to the big three.

Integrated solutions are also an option, with Oracle virtualization in the form of Oracle VM and Sun Solaris, and Red Hat integrated virtualization through KVM. Novell also includes Xen-based virtualization; however its future is somewhat unclear, with the acquisition of Novell by Attachmate, and the transition of some patents to Microsoft.

Partner Ecosystem

In addition to the hypervisor vendors themselves, many of the hypervisor vendors' partners have developed additional tools for managing the virtual infrastructure. This virtualization vendor partner ecosystem has exploded over the past five years. The explosion began with vendors jumping on the VMware management bandwagon. More recently the ecosystem has expanded to support multiple hypervisors as the market has matured.

Many of the early startups have been acquired by one of the major players (in particular VMware, Microsoft and Citrix), which has contributed greatly to their integrated management offerings. This ecosystem continues to grow and change, and is still rife with mergers and acquisitions. Figure 7 shows the virtualizationpartner ecosystem, with virtualization managementdivided up into seven different functionalmanagement areas. The key players in the ecosystem are depicted on the chart, based on where their management capabilities and offerings fit within those functional areas.

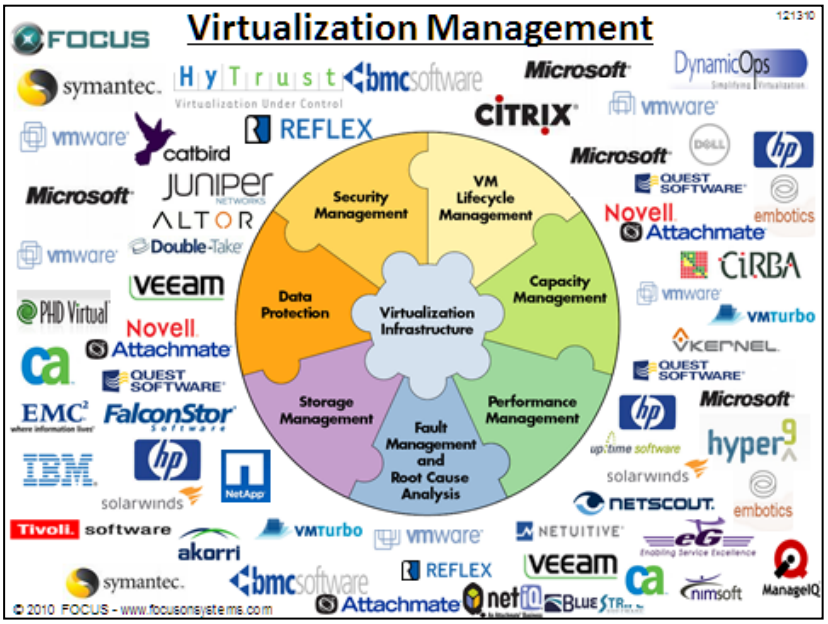


Figure 7. Virtualization Management Ecosystem

Section 7: The Focus Short List

The following offerings are recommended for Basic and Advanced Buyers of server virtualization.

Focus.com Server Virtualization Recommendations for Basic Buyers

BASIC BUYER RECOMMENDATIONS	COMMENTS
Citrix XenServer	For SMB shops running a mixture of Windows and Linux, XenServer offers a solution which can be run alone or alongside Hyper-V using unified management tools across both hypervisors. For organizations planning to implement desktop virtualization as well, XenServer integrates tightly with Citrix XenDesktop to deliver a broad set of desktop delivery use cases. (Note that XenDesktop can also run on Hyper-V or VMware ESX as well)
Citrix Essentials	Add-on management services and tools to manage both XenServer and/or Hyper-V
Microsoft Hyper-V	For SMB organizations running pure Windows environments, Microsoft Hyper-V offers relatively easy server virtualization as a free part of Windows Server 2008, allowing virtualization to be implemented using "the Windows you already know" enabling a fast on ramp to virtualization. Available also in a standalone version (Hyper-V Server 2008)
Microsoft Hyper-V Manager	Free tool for very basic VM management which allows you to Start, Stop, Save State, and Pause VMs running on an individual Hyper-V server
Microsoft Systems Center Essentials (SCE)	For additional management capabilities designed for basic buyers, SCE is a Systems Center management pack designed for midsized businesses (50-500 PCs). Provides a single console for managing a broad range of tasks across servers anddesktops (virtual and physical), hardware, software, and IT services
VMware ESX/ESXi/ vSphere	For higher skilled basic buyers looking for a starting point that can take them to higher end capabilities long term, vSphere offers a solid foundation, which can be purchased in SMB packages for less up-front cost.
VMware vCenter (or packaged as VMware Essentials bundle for 3 hosts)	Add-on management capabilities of vCenter are generally a part of any vSphere implementation, and build the base for all the additional management capabilities that might be added over time.

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Focus.com Cloud-based Server Capacity Recommendations for Advanced Buyers

ADVANCED BUYER RECOMMENDATIONS	COMMENTS
Citrix XenServer	As of 2009 releases, XenServer has all the functionality needed for an enterprise class product, particularly for organizations already using Citrix products. Also strong option for those connecting into Xen public clouds, and longer term connections into Citrix NetScaler front ends for Internet and cloud services.
Citrix Essentials	Add-on management services for XenServer and Hyper-V.
Microsoft Hyper-V	As of WS2008 R2, Hyper-V has all the functionality required for an enterprise class product. Additional improvements such as dynamic memory available in SP1.
Microsoft Systems Center Virtual Machine Manager	Add-on management capabilities for virtualization including live migration and more. Integrates with other Systems Center tools for virtual and physical management. Also the planned base for Hyper-V cloud management functions slated for 2011.
Microsoft Virtual Machine Manager Self-Service Portal	Free add-on to VMM to dynamically pool, allocate, and manage resources inside a private cloud
Oracle	Oracle offers its own hypervisor for virtualizing Oracle products running on a complete Oracle stack. Until late 2010, Oracle did not officially support Oracle running on other hypervisors.
Red Hat Enterprise Virtualization	Red Hat offers its own hypervisor functionality within its Linux products, based on the KVM hybrid hypervisor developed by Qumranet, which was acquired by Red Hat. Red Hat originally incorporated open source Xen, but subsequently switched to KVM and dropped support for Xen.
VMware vSphere	Industry leader for high-end enterprise organizations with advanced management requirements and near-term private cloud goals.
VMware vCenter Server	Cornerstone of vSphere and vCloud management
VMware - additional management products (for example, as packaged in the Enterprise Plus Cisco Nexus 1000v Bundle)	VMware offers a long list of management products, both standalone and packaged together, for advanced management capabilities. These include Data Recovery, Hot add, Fault Tolerance, vShield Zones, Storage VMotion, Dynamic Resource Scheduling, Dynamic Power Management, Distributed Switching, Host Profiles, Storage Multi-pathing, 8-way vSMP and Cisco Nexus 1000v

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Section 8: Conclusions

Server virtualization is a key technology for organizations of all sizes, and will be a foundation for transforming both on-premise data centers and cloud computing. It is already in use in over 95 percent of enterprise organizations, and is a top priority in 2011 for SMB organizations.

Server Virtualization: Eight things to consider before taking your next step

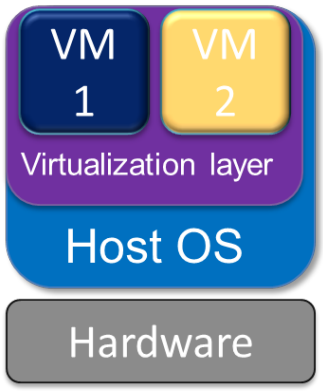
1. If you haven't already started virtualizing, start now.
2. The virtualization landscape has changed dramatically over the past few years. Evaluate the state of virtualization now, based on your needs now and in the future.
3. Don't ignore the possibility of a multi-hypervisor environment, especially for larger organizations.
4. If you've started virtualizing, and are experiencing VM stall or VM sprawl, don't let it stop your progress. Evaluate the virtualization management ecosystem and choose from a wide variety of management tools. This will be the path to private cloud.
5. Consider desktop and application virtualization either as a first step or next step. It is the new hot spot of virtualization, and will change the desktop landscape significantly.
6. Take a holistic approach – look at how to optimize the whole virtual infrastructure. Break the IT silos - server, desktop, storage, networking, security -and create cross-functional teams for product evaluation and implementation planning.
7. Get expert help (online, vendors, channel partners, systems integrators, consultants), especially if you are a basic buyer. The road to virtualization and private cloud is extremely rewarding, but has many potholes. Travel the road with a guide who knows where the potholes are.
8. Go beyond server consolidation and consider the big picture – space, power and cooling; reliability, availability and serviceability (RAS); rapid provisioning; performance, scalability; elasticity; automation; policy-based management; security; organizational issues, total costs and ROI.

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Appendix A - History of the Server Virtualization Market

Virtualization has been around on mainframes since the 1960s, but was not available on the x86 platform until VMware developed workarounds for the x86 architecture. The initial VMware x86 virtualization solution ran on a PC, and became the VMware Workstation product. VMware introduced their first server virtualization product (VMware GSX, later renamed VMware Server) in 2001, as part of a hosted approach to server virtualization solutions.

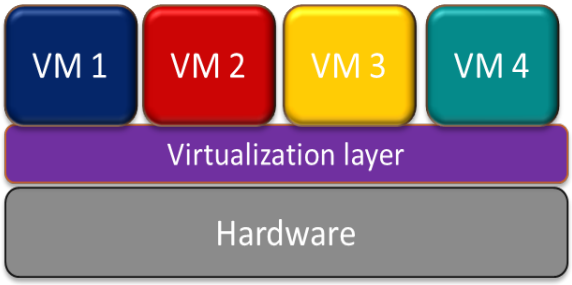
Figure 8. Virtualization Architecture - Type 2 Hypervisor



Hosted architecture solutions also included Microsoft (which in 2003 acquired a company called Connectix and their Virtual Server and Virtual PC technology). With a hosted architecture, now known as a Type 2 Hypervisor (see Figure 8), the virtualization layer was built on top of the operating system. These solutions helped start the early wave of server virtualization, but because of the performance overhead of this approachthey were notutilized for widespread adoption.

Another approach to server virtualization was based on a different architecture. With this architecture, a thin virtualization layer executes directly on the server hardware, and the guest operating systems run on the virtualization layer (see Figure 9). The enabling software is called a bare metal hypervisor, now often called a Type 1 hypervisor. This approach significantly reduced the overhead of virtualization.

Figure 9. Virtualization Architecture - Type 1 Hypervisor



In 2001, VMware also released ESX, the first type 1 hypervisor, which became the foundation for their enterprise product line, including Virtual Infrastructure or VI 3 (2006), ESXi (2007), and vSphere (2009). There have continued to be many additional enhancements across these product releases, continuing to lower overheard and improve performance. VMware was acquired by EMC in 2004, and went public in 2007.

The Xen open source hypervisor began as a as a research project at the University of Cambridge, led by Ian Pratt, who then founded XenSource, and released the first version of Xen in 2003. That solution used paravirtualization, which required modifications to the guest operating systems to run under Xen. The hardware chip manufacturers then joined the virtualization wave and added hardware-assisted virtualization into the x86 chipsets, resulting in the Intel-VT and AMD-V products. These chipsets were leveraged by the XenSource Xen open source hypervisor to no longer require paravirtualization and guest OS modifications. (Version 3.0 became commercially available in 2006). XenSource was subsequently acquired by Citrix in 2007. Citrix still maintains both the open source Xen, as well as the Citrix commercial XenServer product line.

The Xen open source hypervisor became the basis for other virtualization platforms, including those offered by Oracle, Sun, and Linux vendors Red Hat and Novell. Red Hat later acquired a company called Qumranet that had implemented a hybrid hypervisor variation for Linux. Called KVM (for "kernel virtual machine"), Qumranet also used this solution for its desktop virtualization product called Solid ICE. KVM has now been adopted into the Linux kernel, and Red Hat now supports KVM rather than Xen.

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Microsoft continued to sell Virtual Server, its Type 2 hypervisor, until Hyper-V was released in 2008. Hyper-V requires hardware assisted virtualization and therefore does not run on older hardware (pre-Intel-VT or AMD-V). Hyper-V first became available as part of Windows Server 2008, then was also made available as a standalone solution. The initial version, Windows Server 2008 R1, was missing key features required for most production and enterprise environments, most notably live migration (the ability to move a running VM from one physical host to another with no disruption). Enterprise management features were incorporated in R2, which shipped in mid-late 2009, making it a viable choice for both SMB and enterprise organizations. Additional enterprise features are part of R2 SP1, making it an even stronger enterprise option.

Additional improvements continue to be made to the hardware assisted virtualization chipsets, which are now leveraged by all three vendors to reduce overhead. More recent improvements have been very strong in the areas of memory management and paging, as well as I/O performance.

Another approach to server virtualization, called OS virtualization, also played in this market dating back to 2001. OS virtualization, also sometimes called "containers," was used by SWsoft in its Virtuozzo product, which was mostly successful in the service provider arena. OS virtualization creates multiple separate containers within the OS, so that each virtual environment or container is a slice of the same version of the base OS. It offers very low overhead, since the virtual environments share the OS, but offers less flexibility, since they must all run the same OS copy and version. The container architecture was also used in Sun's Solaris containers which first shipped in 2005 in Solaris 10.

In 2004, SWsoft acquired a company is the desktop virtualization space called Parallels, and changed all products to the Parallels name. Parallels introduced a Type 1 hypervisor in 2009, also designed for the service provider space in which SWsoft had a strong presence. Parallels Server 4 Bare Metal, which was designed with multi-tenancy and scalability in mind, competes with other Type 1 hypervisors mostly in that service provider space, but has not yet matured to include all the management features that its competitors have developed and is not a strong contender in either the SMB or the enterprise IT direct markets, and thus not covered in detail in this Guide.

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Appendix B – The Path from Server Virtualization to Private Cloud

Private cloud computing can be defined as the use of virtualization and other dynamic technologies such as policy-based management, rapid and self-service provisioning, and usage-based accounting to allow services on an internal (in-house) infrastructure to be delivered as a utility. Because private cloud is so closely tied to virtualization, it is important to understand the steps in the path from server virtualization to private cloud.

1. The path starts with a virtual infrastructure as the base foundation (see Figure 10). This foundation allows for dynamic movement of workloads from one physical device to another. It also allows for rapid provisioning of new workloads as needed.
2. As organizations expand their use of virtualization, storage and networking are typically the top pain points, and often become bottlenecks. Optimizing storage and networking through networked storage, virtualization and the right management tools for performance management and troubleshooting are critical to successful expansion, particularly to business/mission critical applications. The next step is to automate the processes of provisioning and managing the ongoing management activities. This requires a policy based approach, with IT setting up the policies, and automated management software then doing the ongoing management. This is the foundation for a self- managing compute infrastructure.
3. The next steps are key elements of the paradigm shift to “cloud-like” behavior. That shift allows users to request IT services themselves, with IT automatically provisioning those services on the back end and tracking the costs involved.
4. Cost visibility, originally called "chargeback," means providing a way to track the costs involved in a service, including portions of all the compute, network and storage resources involved in that service. It is up to the organization as to whether the user actually pays their share (chargeback), or the organization simply tracks it for management purposes ("showback") as all well-managed IT organization should.
5. Once policy-based management and provisioning are in place, and usage can be tracked for cost management, IT can then open up self-service portals to allow users to request services.
6. The last key component is to advertise a catalog of those services, from which users can select what services they want.

With all these steps added to a base virtual infrastructure, an organization can move from basic consolidation to the delivery of IT as Service, otherwise known as private cloud.

Figure 10. The Road from Virtualization to Private Cloud

FROM VIRTUALIZATION TO PRIVATE CLOUD
Virtualized Infrastructure
Storage and networking optimized for virtualization
Automated policy-based dynamic resource management
Usage based cost visibility – chargeback/showback
Self-service provisioning
Catalog of services

Source: FOCUS, LLC

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* Source: Visa, Inc. Commercial Consumption Expenditure Index fact sheet.

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