
Server Virtualization: Emerging to Mainstream at Lightspeed

Gartner Symposium ITxpo 2009

Thomas Bittman

October 18-22, 2009
Walt Disney World Dolphin
Orlando, FL

Notes accompany this presentation. Please select Notes Page view.
These materials can be reproduced only with written approval from Gartner.
Such approvals must be requested via e-mail: vendor.relations@gartner.com.
Gartner is a registered trademark of Gartner, Inc. or its affiliates.

This presentation, including any supporting materials, is owned by Gartner, Inc. and/or its affiliates and is for the sole use of the intended Gartner audience or other authorized recipients. This presentation may contain information that is confidential, proprietary or otherwise legally protected, and it may not be further copied, distributed or publicly displayed without the express written permission of Gartner, Inc. or its affiliates. © 2009 Gartner, Inc. and/or its affiliates. All rights reserved.

Gartner

Server Virtualization Myths



Myth: It's already common.

Fact: Only approximately 16% of workloads are running in virtual machines today — about half by YE2012; the fastest growing market today is small business.



Myth: It's primarily about saving money.

Fact: Large enterprises virtualized to save money, but later surveys show that the key is agility; small enterprises never consider saving money the primary reason to virtualize.



Myth: Virtualization is a commodity.

Fact: Virtual infrastructure technologies drive management technologies that drive private cloud architectures that determine cloud-computing strategies.

Gartner

Key Issues

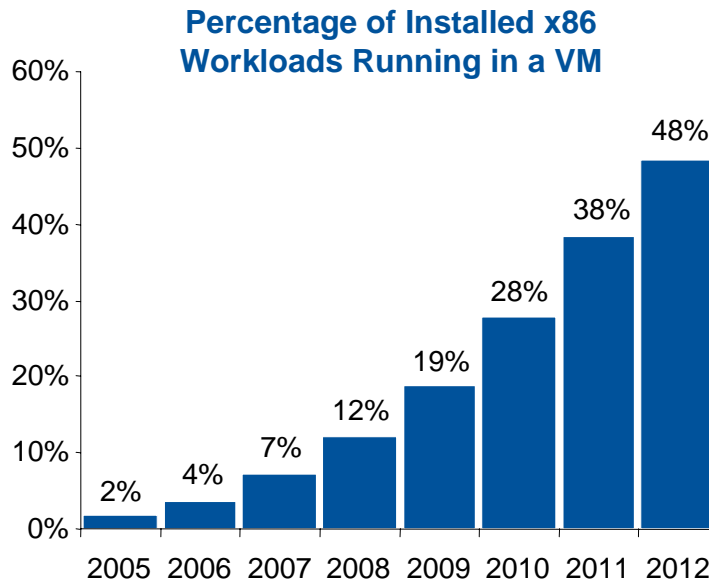
IT virtualization is the abstraction of IT resources in a way that masks the physical nature and boundaries of those resources from resource users.

1. How is the market adopting server virtualization?
2. How should users select, deploy and manage server virtualization technologies?
3. How will server virtualization technology evolve?

Gartner

Virtual Machines: Moving From Niche to Mainstream

- Large enterprises started sooner — Global 500 (G500) are perhaps 25% virtualized
- Small or midsize businesses (SMBs) started later, and tend to be less virtualized
- SMBs are virtualizing very fast — will exceed G500 penetration in 2009 or 2010

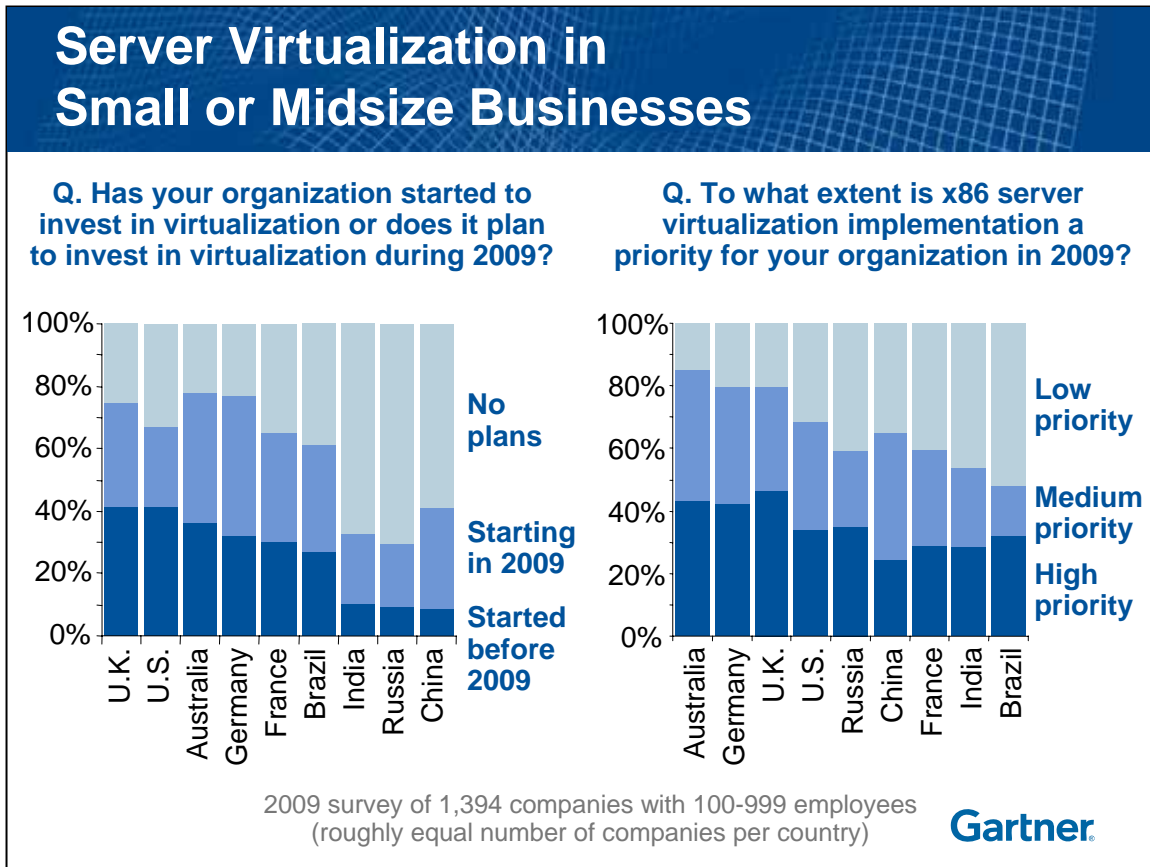


Gartner

From 2002 through 2008, the number of virtual machines installed on x86 servers grew at a compound annual growth rate (CAGR) of 102%. As of the end of 2008, roughly 12% of all x86 architecture server workloads were running in virtual machines (approximately 16% as of August 2009). From 2009 through 2012, this torrid growth will continue, although at a slower 66% CAGR. By 2012, nearly half of all x86 server workloads will be running in virtual machines.

The number of virtual machines installed will grow by a factor of 10 from 2008 through 2012. By 2012, there will be approximately 58 million virtual machines deployed.

Strategic Planning Assumption: By year-end 2010, enterprises with 100-999 employees will have a higher penetration of virtual machines deployed than the Global 500.

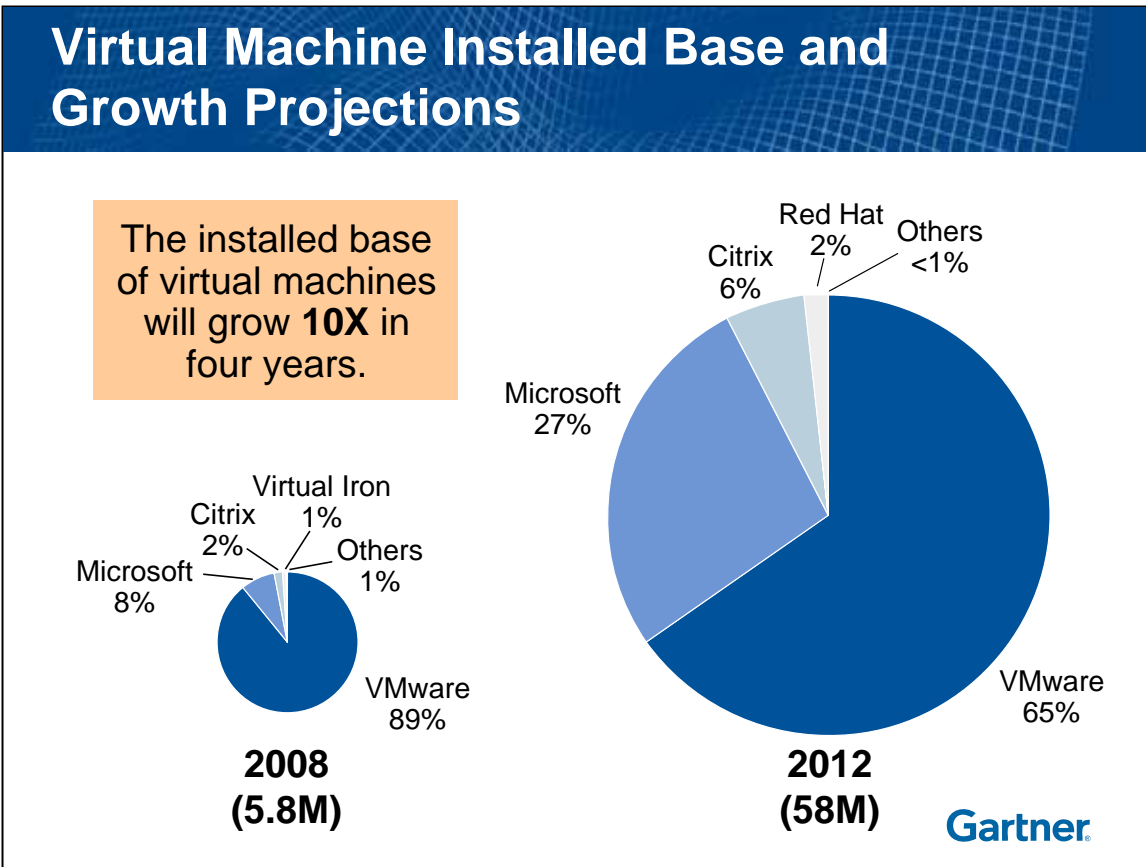


Key Issue: How is the market adopting server virtualization?

Small businesses started late on virtualization. While large enterprises were quick to leverage virtual machines to reduce server sprawl and power costs, as well as conserve data center space, small enterprises have been much more interested in ease of use, simplicity and operational improvements. As the only player in the market for years, VMware's entry price was simply too high for many small companies. While VMware sold to many thousands of small companies, many more sat on the sideline and waited.

When Microsoft introduced Hyper-V in mid-2008, as small companies started deploying Windows Server 2008, they gave Hyper-V a try. VMware had done a good job of preparing the market by selling the virtualization concept, but often the resulting product they acquired was Hyper-V. VMware has found the midmarket to be extremely competitive, which has forced them to introduce new lower-priced offerings as a part of the vSphere announcement.

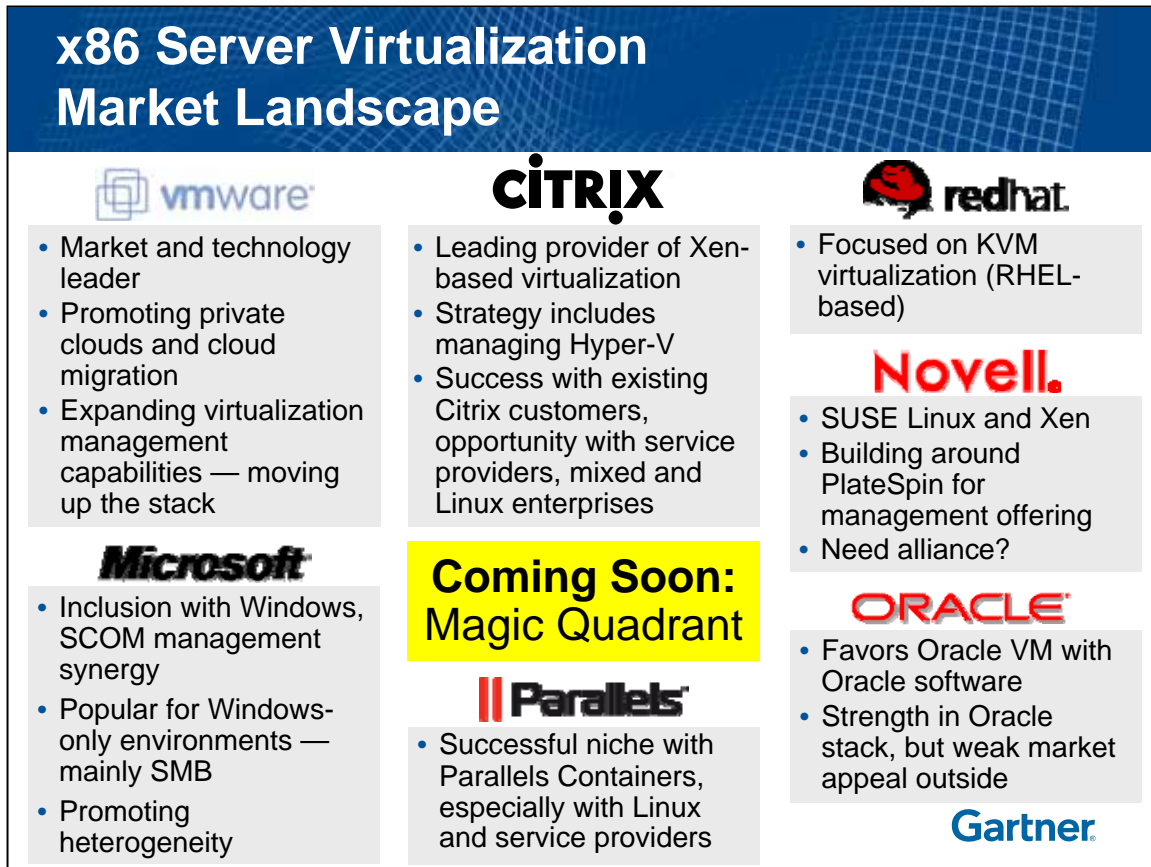
Gartner believes that this market will accelerate markedly throughout 2010, as Hyper-V R2 proves itself (including live migration), alternatives such as free XenServer, VMware Essentials and Red Hat's KVM-based solution make for competitive choices. Unlike large enterprises, smaller companies tend to go from 0% virtualized to near 100% very quickly — often in one project, in one year.



Key Issue: How is the market adopting server virtualization?

VMware will leverage its existing penetration of large enterprises to maintain an overall market share of 65% by 2012. However, they will only get a small portion of the rapidly growing small-and-midsized market using virtual machines. VMware's focus will continue to shift upward in the stack — more application management, more application platform capability, more private cloud capability, bridging technology between a VMware-based enterprise and a VMware-based service provider in the cloud, and so on.

Microsoft's share will grow rapidly. In August 2009, Microsoft delivered Windows Server 2008 R2, including Hyper-V live migration, eliminating a major roadblock to Hyper-V deployments. Microsoft's installed base share will grow to a solid 27% of the market by 2012 — approximately 15 million virtual machines. However, Microsoft's dominance will remain in the small-to-midsized market, with only a much smaller penetration into large enterprises. Furthermore, a large number of Global 500 enterprises will have some Hyper-V, making heterogeneous management and interoperability much more important issues. By 2012, Microsoft will have also improved their own capability to bridge between enterprises using Hyper-V and their cloud offering — the Windows Azure Platform. This may also have the effect of making Hyper-V the enemy of third-party service providers, who will tend to use non-Microsoft virtualization infrastructure.



As of August 2009, approximately 85% of installed virtual machines in enterprises (as opposed to service providers) are VMware-based virtual machines. VMware is even more dominant in Global 500 enterprises, which generally started virtualizing early, when VMware was the only competitor in the market. They also leverage higher-end tools such as VMotion heavily, and are more demanding in their production use of virtual machines.

In the same period, Microsoft has grown to nearly 10% installed base market share (which was also their market share peak with Virtual Server 2005 in 2007). Microsoft is mainly attracting newcomers to virtualization, which are still mostly smaller enterprises, with deployments of 100 virtual machines or less. However, because of the very large pricing gap with VMware, Microsoft is winning some larger enterprises, which may eventually force VMware to become more aggressive on pricing.

Now that Citrix is giving away XenServer, they are attracting a growing base of users — their installed base accounts for more than 3% of the virtual machine installed base (which mean approximately 300,000 virtual machines). XenServer is most attractive to existing Citrix customers, but is also seen as a leading contender in heavy Linux-based enterprises, or mixed Linux- and Windows-based enterprises.

The rest of the vendors — Oracle (including Sun), Novell, Red Hat and Parallels — account for approximately 1% of the installed base today. A large percentage of that is the Virtual Iron installed base that Oracle inherited from the acquisition. However, since Oracle has declared the Virtual Iron technology dead, those users are often looking at alternatives, such as Citrix.

Strategic Planning Assumption: By 2012, at least 25% of the virtual machine installed base in enterprises will be Microsoft Hyper-V.

VMware or Microsoft?

By 2012, at least 25% of the virtual machine installed base in enterprises will be Microsoft Hyper-V.

Microsoft

Reasons to choose Microsoft:

- Smaller deployment (<100 VMs)
- Server virtualization is primarily being used for less-critical servers
- Exclusively or primarily using Windows operating system
- Heavy user of Microsoft management (Systems Center)
- Low cost more important than features
- Simplicity in managing a mixed physical server and virtual server environment important

vmware

Reasons to choose VMware:

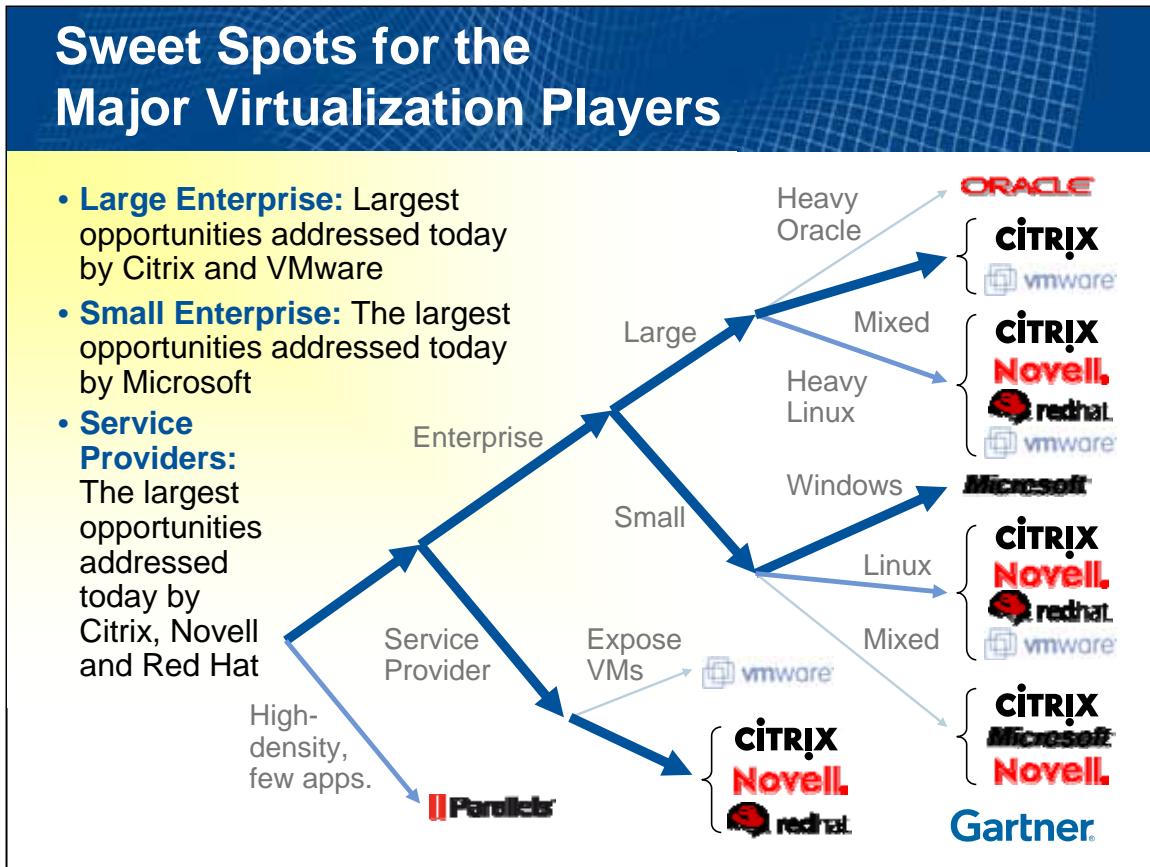
- Existing investment in VMware skills, technology, automation
- Large deployment (>200 VMs)
- Low tolerance for downtime
- Requirement for high density of VMs per server
- Mix of server operating systems
- Maturity and features more important than low cost
- Building a VMware-centric private cloud infrastructure and the vCloud initiative are attractive

Key Issue: How should users select, deploy and manage server virtualization technologies?

With Hyper-V R2 and SCVMM R2, Microsoft has become a very viable alternative to VMware for server virtualization deployments.

Microsoft is an excellent choice in environments with a relatively small number of servers due to the lack of maturity of live migration, the lack of turnkey automation tools to drive live migration, and the single point of failure on Windows Server 2008 for every host. Microsoft also is an excellent choice in an all-Windows environment (Hyper-V will only support Windows Server 2000, SUSE Linux and RHEL with a single virtual processor per VM). While there is not a tremendous synergy with Systems Center yet, the tools will become more integrated over time, and SCVMM is very easy to learn for a Systems Center user.







VMware will remain the primary choice for users that have already adopted VMware — especially due to their investment in skills, and advanced features that Microsoft does not yet have. Large deployments (greater than 200 VMs) are best managed by VMware, due to the maturity of VMotion and Distributed Resource Scheduler (DRS) automation. VMware does not rely on a large parent operating system like Microsoft, and therefore has less unplanned downtime. VMware's memory overcommit approximately 20% higher VM density on average (better density when VMs are very peaky). VMware also has a well-defined migration path to private cloud and cloud computing in general that is attractive to organizations that want to build toward cloud computing using VMs.



Key Issue: How should users select, deploy and manage server virtualization technologies?

VMware is by far the market leader with the most robust technology and the richest strategy for expanding virtual machines into the private cloud and bridging to public clouds. Their strength is in very large enterprise deployments. However, the newly growing market of small-to-midsized users are attracted to the Microsoft model — not as robust, not as easy to manage in large volumes, but much cheaper and certainly easy for smaller deployments. Microsoft will surely continue to improve. In mixed environments (Linux and Windows) where VMware pricing is too steep, Citrix is a reasonable and proven choice today, with a road map that probably leverages Hyper-V in the future. For architectures that rely heavily on Oracle and Oracle Enterprise Manager, Oracle VM is a fine gap-filler.

What is clear is that this very dynamic market will continue to shift rapidly over the next few years. Acquisitions, strategy shifts, the maturity of cloud computing (for the right services) will determine the future of these vendors. Heterogeneity, interoperability, migration to and from cloud providers, management of virtual infrastructures both in the cloud and spanning on-premises and off-premises are factors that may not be important now, but will become critical within a few years.

Major 2009 Industry Announcements		
	Announcement	Advice, Ramifications
	<ul style="list-style-type: none"> XenServer free Essentials for Xen, Hyper-V 	<ul style="list-style-type: none"> Momentum — Essentials is now key — consider in Linux or mixed environments
	<ul style="list-style-type: none"> Acquisitions of Sun (proposed) and Virtual Iron 	<ul style="list-style-type: none"> Use when Oracle is managed separately, and sharing outside Oracle not critical
	<ul style="list-style-type: none"> vSphere 4.0 and pricing Acquired SpringSource 	<ul style="list-style-type: none"> Continues to push boundaries (now I/O performance and so on), price is "only" major issue
	<ul style="list-style-type: none"> Hyper-V and SCVMM R2 (including live migration) 	<ul style="list-style-type: none"> Live migration fills big gap, large single point of failure still concern — but not for SMBs
	<ul style="list-style-type: none"> KVM-based rollout (RHEV) late 2009 	<ul style="list-style-type: none"> Serious alternative, especially for service providers, Linux and mixed environments
	<ul style="list-style-type: none"> Parallels Server delivery in late 2009 	<ul style="list-style-type: none"> Not as important or differentiated as Parallels Virtuozzo Containers

Key Issue: How should users select, deploy and manage server virtualization technologies?

Although there are a number of new competitors in the virtual machine market, the market will tend to be dominated by two players: VMware and Microsoft.

VMware already has a large installed base and a significant toehold in most large enterprises. VMware's rich management capabilities, including VMotion and DRS to automate live migrations, are significant advantages, especially compared with Microsoft (which just introduced live migration capability in mid-2009). Large enterprises are already on the path to leveraging VMware features and using VMware management tools. Switching will not be a pragmatic option — at least for a few years.

Although there are many midsize businesses using VMware, VMware's share of the midsize market is tiny compared with its share of the large enterprise market. The midsize business market is nearly a "greenfield" opportunity, and it is also a market that Microsoft can influence greatly. Microsoft will become the dominant vendor for midsize and small businesses. VMware still has opportunity, but that window of opportunity is closing fast — and VMware will find it difficult to price for that market.

Tactical Guideline: The biggest concern about Hyper-V is its dependency on a copy of Windows Server 2008 — a large single point of failure.

What's Big in VMware vSphere 4.0 and Microsoft Hyper-V/SCVMM R2

VMware	Microsoft
<ul style="list-style-type: none">• I/O performance (direct I/O)• Host scalability: 64 cores, 1 TB, 256 VMs• VM scalability: 8 cores, 255 GB• Thin provisioning, hot disk extend, volume grow• Distributed switch• Network VMotion• vCenter<ul style="list-style-type: none">• Host profiles and Orchestrator• Manage 300 hosts, 3,000 VMs• Linked mode — manage up to 10,000 VMs• Distributed Power Management• Fault tolerance• VMsafe and vShield Zones• Hot add CPU, memory• New packaging: Essentials through Enterprise Plus	<ul style="list-style-type: none">• Live migration• Processor compatibility (software)• Host scalability: 64 cores, 1 TB, 384 VMs• VM scalability: 4 cores• Clustered Shared Volumes (multiple VMs per LUN)• Core parking• SCVMM R2<ul style="list-style-type: none">• Quick storage migration (2 min.)• Hot add/remove storage• Live migration queuing• Host maintenance mode

Gartner

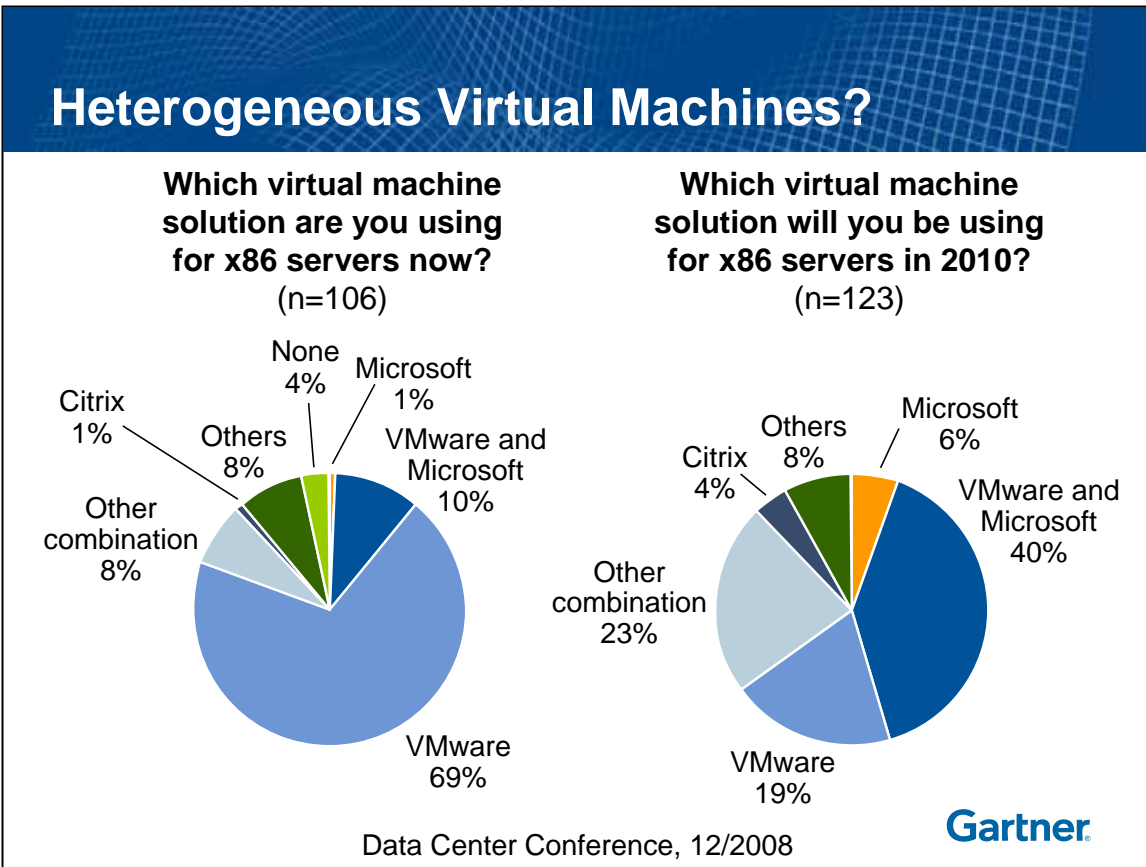
Key Issue: How should users select, deploy and manage server virtualization technologies?

VMware remains firmly ahead of Microsoft in the virtualization feature arena, but the real question is when Microsoft's feature list is good enough for specific customer requirements.

The biggest gap prior to Hyper-V R2 was live migration. VMware's VMotion is a popular tool for managing planned downtime, and a necessity in very large virtualized environments. Because of the need to patch the parent Windows OS for Hyper-V, clients have told us they need live migration to mitigate planned downtime of the host.

Microsoft has yet to prove it can match VMware for I/O performance — but most early adopters of Hyper-V haven't been pushing their I/O requirements.

Perhaps the biggest missing feature is Dynamic Memory — originally in R2, but pulled. Dynamic Memory is Microsoft's answer to VMware's memory overcommit. It allows a server to have more virtual memory configured than is actually physically available, which increases VM density. While a nice feature, most users aren't deploying Hyper-V virtual machines at very high densities yet. If Microsoft can deliver this within a year or two, that's going to be good enough for most users.






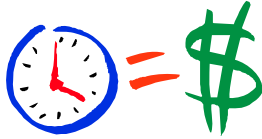


Key Issue: How should users select, deploy and manage server virtualization technologies?

Sourcing from two vendors can often be a method to drive more competitive pricing. However, it can also create complexity and additional administrative costs. This is especially true with server virtualization. Gartner has recommended that users avoid heterogeneous virtualization stacks if possible, due to the need for parallel skill sets. While Microsoft's Systems Center VMM can manage VMware, it requires that users buy nearly the full VMware stack — saving users little money. It can be a useful migration strategy, but there is little benefit in establishing that as a long-term heterogeneous solution.

Gartner believes that customers will have combinations of hypervisors and management stacks over time — especially customers that are migrating from one technology to another, or customers that have IT units that are managed independently or through acquisitions. Some applications may also drag in a technology — especially Hyper-V.

However, a large percentage of clients surveyed at our December 2008 Data Center Conference in Las Vegas believe that heterogeneity will be the norm by 2010. Gartner believes that this is more of a client intention than a reality. But it highlights that vendors will be advantaged if they promote heterogeneous management. Gartner recommends that clients be cautious about vendor claims to heterogeneous support, and evaluate their real needs before they buy.

Best Practice: Virtualized server deployments should start small and incrementally, but strategic planning regarding management and process changes is critical.

Best Practices: Starting to Virtualize Servers	
 Start small	But think big 
 Require rapid ROI	But think agility 
 Be application smart	Pool well  Gartner

Key Issue: How should users select, deploy and manage server virtualization technologies?


We have often talked to clients who have deployed virtual server capability, only to find that users are concerned about sharing their servers. The "if you deploy it, they will come" strategy often fails to attract users. The better approach is to find a willing user or a specific project, and concentrate on building a success story. Real metrics help to prove the point — metrics for cost or chargeback (if it is employed), planned downtime, unplanned downtime and, especially, speed of deployment. Pilot projects help IT professionals understand what works and what doesn't quite work well yet, and helps them make better decisions on the speed and directions of server virtualization deployments.

While starting small is important, it is also important to think big. Virtualization is seen as the solution for server sprawl. However, due to the ease of deployment, the ability to snapshot images and the abstract nature of virtual machines, virtual machine sprawl is potentially a bigger and more insidious issue. It is very important to plan ahead for centralized virtual machine life cycle management and accounting. Likewise, the effects of virtualization on operational processes cannot be overstated. Virtualization changes virtually everything, but better to plan for those changes rather than react.

Having a strategic plan for server virtualization — what happens next year, and the year after that — helps you avoid surprises that could delay your plans, cause failures or affect the overall return on investment.

Strategic Imperative: Virtualization will be the highest-impact trend in infrastructure and operations through 2012, changing how you manage, how and what you buy, how you deploy, how you plan and how you charge.

Operationalizing Virtualization: Mind Your Porridge



- **Too cold** and you won't achieve potential savings
- **Too hot** and you'll have VM sprawl, cost overruns, breakdowns
- Be proactive, and plan ahead to be **just right**

Assets/Configuration	Performance/Capacity	Funding/Chargeback
<ul style="list-style-type: none"> • Don't wallpaper over problems • Expect higher demand, more transient usage • Manage the speed (approvals, quotas, chargeback, reporting) • Don't forget offline "assets" • Dependency management gets harder • Descriptive metadata will evolve • Be strategic — cloudsourcing is coming 	<ul style="list-style-type: none"> • Merging: Incremental, asynchronous capacity changes • Shift to holistic capacity planning • VM placement important — but don't over-analyze or over-optimize • Beware of VM performance overhead and VM resource competition • Descriptive metadata will evolve 	<ul style="list-style-type: none"> • Virtualization <-> "free" • From project-based to usage-based — asynchronous asset buying • Account for all usage, expose simplicity (less dynamic, less detail, more predictable) • Build metrics that are not dependent on physical hosts — and lead to external cloud alternatives <p style="text-align: right;">Gartner</p>


Key Issue: How should users select, deploy and manage server virtualization technologies?

Server virtualization challenges much traditional IT infrastructure orthodoxy, and this has ramifications for its management. First and foremost is speed (deployment, change, movement). Second is location (from physical to logical, from on-premises to off-premises). Third is encapsulation (from operating systems and images to virtual machines and files). The changes fundamentally change how IT is managed.

Moving too fast into server virtualization often causes some degree of breakage. Even though some quick wins are often delivered, there is too small a base to build on for future efforts — it becomes a "rip and replace" architecture that is wasteful. On the other hand, never-ending "proofs of concept," which you may find in conservative organizations do not necessarily deliver the prudence that they often tout. Instead, momentum stalls occur and customers of these organizations find that their costs also rarely improve because economies of scale, whether related to technology, process or skills, usually do not materialize. The "just right" approach seeks middle ground — starting small to reduce risk (and provide time for a learning curve) but which also builds the foundation for sustainable reductions in TCO and improvements in service quality. The other aspect, which includes "thinking big," enables the development of the supporting IT scaffolding that will lend itself well to the scalability challenges that virtualization will create.

Strategic Guidelines: Most virtual machines you deploy will be less secure than the physical systems they replace. Virtualization will radically change how you secure and manage computing environments.

Securing Virtual Servers: Issues and Possibilities





Issues

- Virtualization introduces new "platform" that must be included in patch, configuration and vulnerability management
- Offline VMs need to be kept up-to-date and protected
- Early virtual switches are not visible to traditional network-based security
- VMs will become mobile — security policies that are not mobile (such as tied to IP or MAC addresses) are broken

Possibilities

- Security appliances shifting from physical and proprietary to virtual
- VM state inspection becomes a new security opportunity, without agents in the virtual machines
- Security decoupled from workloads requires security metadata, enables adaptability — including to the cloud




Key Issue: How should users select, deploy and manage server virtualization technologies?

Conceptually, in the future adaptive data center, there is no difference between a desktop and a server workload in a composite, adaptive model of work spaces (for end users) and workloads (for servers). Both are configured on demand in real-time-based requirements. In the case of desktop work spaces, the requirements are in the form of user preferences. In the case of server workloads, the requirements are in the form of SLAs. In both cases, requirements and context are combined to construct the resultant container.

In parallel, enterprise IT is increasingly being asked to support work spaces and workloads that are unmanaged (for example, portable personalities and virtual appliances). As VMMs evolve to platforms that support VM state inspection (as VMware delivered in June 2009 in vSphere with its VMsafe set of APIs), IT departments are able to externalize security and management policy, and enforce this independently of unmanaged VM containers. This enables IT to build the elusive "control plane," enabling a new process model for IT security and operations in which the management of VMs hosting application functionality can be separated from the security and operation management policy that governs their operation. This isolation and abstraction enables one group to focus on application containers, another group to focus on security policy and tools, and another to focus on operational policy and tools.

Virtualization Is a Modernization Catalyst and Unlocks Cloud Computing



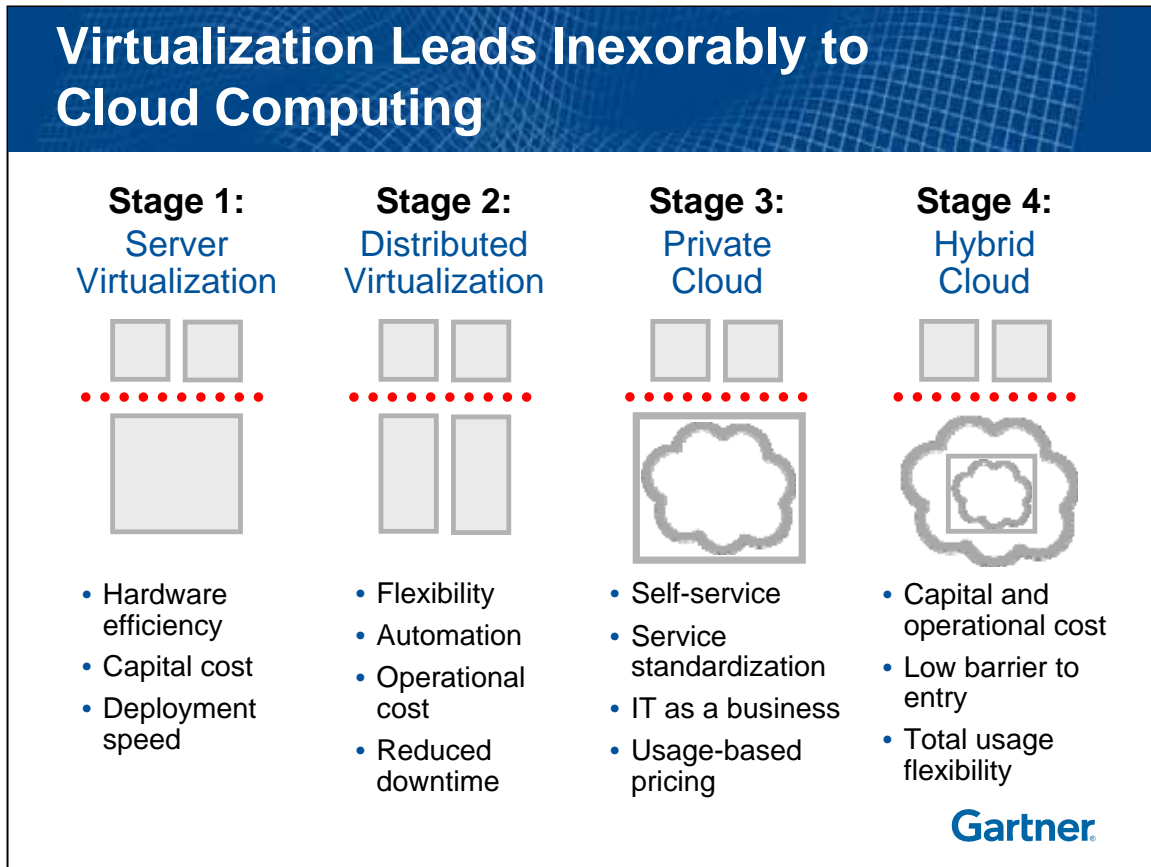
- Enables Economies of Scale**
 - Technology that enables sharing
- Decouples IT From Users**
 - Enables service-oriented shift
 - Enables alternate sourcing
 - Culture change
- Speed and Elasticity**
 - Low barrier to entry
 - Faster deployments
 - Rapid reaction to change
- Breaks Software Pricing and Licensing**
 - Fractional use, consolidated
 - Dynamic change and movement
 - Vendors realize — just don't want to be first
- Enables and Motivates Chargeback**
 - From fixed to variable use
 - Danger of frictionless computing

Gartner

Virtualization is not cloud computing, but it enables and forces the same changes required to effectively leverage cloud computing. Perhaps, the most important aren't even technology changes — they are cultural. For example, virtualization forces users to let go of the physical implementation of their services, and deal with their provider in terms of service levels and results. Many organizations don't have service-level agreements in place, and rely instead on constant interaction with their internal providers to ensure the right performance levels and resolution of issues. When your provider becomes a cloud-computing provider, that intimacy is simply not there, and users will need to do a more complete job of describing their requirements in service terms.

Most organizations don't do chargeback. IT is considered a cost center and is generally centrally funded. Cloud-computing services are, by definition, charged based on usage (unless they are subsidized by advertising). Therefore, users need processes to manage their usage and pay per use. Virtualization is driving many organizations to mechanisms for usage-based accounting, and quite a few of them are moving to a full chargeback model.

Strategic Planning Assumption: By year-end 2012, half of the Global 100 will have at least one service that they consider to be a private cloud-computing service, using virtual machines as a basic building block.



Key Issue: How will server virtualization technology evolve?

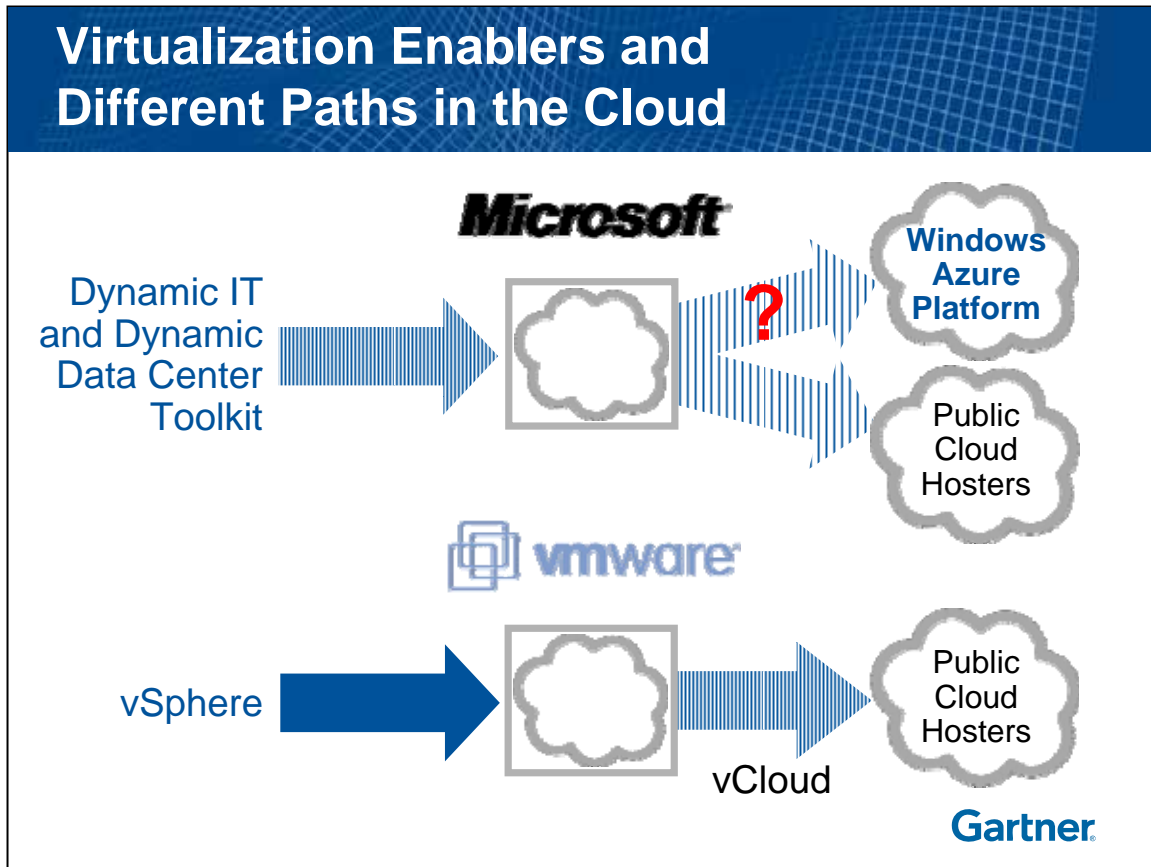
Few organizations seem to understand the strategic ramifications of server virtualization. They tend to think about cost-cutting — virtualization simply as a form of efficient consolidation. We've surveyed our clients — those starting out on virtualization say they are doing it to save money. They are thinking tactically.

There's nothing wrong with saving money but, strategically, virtualization is not primarily about cost-cutting. Strategically, virtualization leads inexorably down a path toward flexible sourcing as well as cloud computing.

Even our surveys show that organizations who are well on their way toward virtualization change their points of view — flexibility, agility and speed move to the top of the list.

Early private clouds will be focused on development and test environments — just like the earliest usage of virtual machines. These services will use virtual machines as the basic building block, provisioned automatically, and using a self-service portal for developers to access.

Private clouds will be extended into public cloud services in a hybrid manner. In some cases, the public cloud will replace the private cloud. In others, they will remain in a hybrid model, with some resources private and some public.



Key Issue: How will server virtualization technology evolve?

VMware has developed a clear vision and road map for enterprises with respect to virtualization, private cloud computing, and cloud computing. VMware's vision is to sell cloud-enabling technology to enterprises and to service providers alike, as well as the tools to enable migration between — and management of — hybrid clouds (vCloud). The vision is compelling to service providers because it opens up the large VMware installed base to public cloud hosters.

Microsoft's vision is less developed at this point. For private cloud computing, Microsoft has developed guidance and best practices in the form of the Dynamic Data Center Toolkit. (There is one for enterprises and another for hosters.) However, with Hyper-V just one year old, there aren't any Hyper-V-based enterprises developing private clouds as of yet. Even less developed is Microsoft's strategy for connecting enterprises to cloud providers. Microsoft wants to sell their enablers to public cloud hosters, but they don't have a strategy to enable migration or hybrid models between enterprises and hosters as of yet. More problematic, Microsoft is a major competitor to hosters, in the form of Windows Azure Platform. Azure targets new applications and, at this point, Microsoft is not considering adding hosting capability. Microsoft needs to decide if Azure will become the enabling software they sell to hosters or if it will remain a separate, niche offering (which is unlikely, given the huge investment in data centers that Microsoft has made for Azure).

Action Plans

CIOs and I&O leaders should ...

- **Now**

- If you haven't started virtualizing, *it's time to start*, and you have a number of alternatives
- If you have virtualized, *perform a health check* on your processes, management and security

- **Your Next 90 Days**

- *Develop* a private cloud strategy and ensure your virtualization plans match
- If you are a Hyper-V customer, *upgrade* to R2
- If you are a VMware customer, *upgrade* to vSphere 4.0

- **Your Next 12 Months**

- *Develop* a cloud strategy and ensure your virtualization plans match

Gartner

Related Gartner Research

- **Server Virtualization for x86: A Benefits Impact Assessment**
Cameron Haight, Stewart Buchanan, Thomas Bittman
(G00165864)
- **Hype Cycle for Virtualization, 2009**
Phil Dawson, Thomas Bittman, et al (G00168837)
- **Tactical Guidelines for Evaluating Virtualization Security Solutions**
Neil MacDonald (G00163703)
- **Best Practices Before You Virtualize Your Servers**
Thomas Bittman, John Enck (G00153718)
- **2008 Data Center Conference Instant Polling Results: Virtualization Summary**
Alan Dayley, Thomas Bittman, et al (G00165676)

Gartner