

TechAlpha Report

Ripple Effects From Virtualization

**With a Critical Perspective on the
VMware vSphere4 Announcement**



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Synopsis

Ripple Effects from Virtualization integrates and quantifies the customer, vendor and channel perspectives on server virtualization in a way which is actionable for executives. Top-level insights from our report include:

Server architecture advances creating greater pressure for consolidation: Rapid growth in cores per server, faster than server software can exploit them, will force customers to virtualize more applications than currently anticipated or risk dramatically underutilizing servers again

High availability and disaster recovery for the masses: Virtualization creates a new platform for delivering HA/DR at a much lower cost than legacy solutions, though vendors have to reach and win credibility with a new buyer, the application owners

Order of magnitude improvements in IT staff productivity: Cloud technologies in the enterprise, growing out of virtualization and service-oriented management, will enable centralized management of complex, multi-tier application services running on cheap pools of commodity infrastructure. The private cloud management layer will be a significant source of new profit pools for vendors in the virtualized data center

Storage commoditization: Server virtualization is increasingly helping to mask the differentiation between storage vendors. This, and the progressive modularization of storage systems, is accelerating the erosion of storage hardware margins and forcing vendors to transition from capacity-based to value-based selling

Server software licensing more like Amazon: Virtualization upends database and middleware pricing and potentially vendor business models. Licensing for virtualized pools of capacity enables customers to substantially reduce their forward buying of licenses and deploy “just in time” instead of “just in case”

Spotlight on VMware: With the arrival of a new CEO, we believe the company is putting significantly more emphasis on an advanced vision for its desktop business, one which Microsoft is likely to be more hesitant to follow. The assets it originally brought to its single vendor vision of a virtual datacenter OS initiative are likely to encounter strong competition from Microsoft, BMC, CA, HP, and IBM. There is also the likelihood **that VMware’s data center business objectives will conflict with those of parent EMC**, since VMware commoditizes storage. The real battle for VMware is likely to be with Citrix over an advanced vision for desktop virtualization

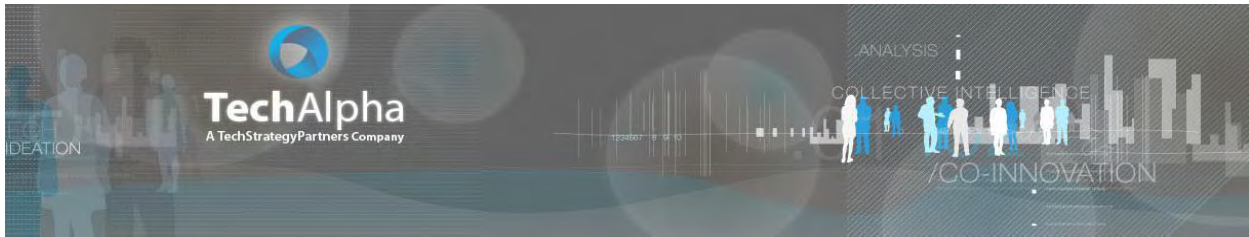


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I. Executive Summary

Virtualization allows software to catch up with hardware performance improvements while achieving a 10x boost in IT labor productivity.

That virtualization can be used to consolidate servers is well understood. However, software cannot keep up with the rapid advances in hardware performance without virtualization, and that will drive penetration higher than expected. In particular, rapidly increasing mainstream server capacity in terms of cores per socket is likely to force customers to virtualize more applications or risk dramatically underutilizing servers again.

Building on that platform and the business continuity and private cloud management follow-on capabilities, TechAlpha expects the penetration rate for server virtualization to reach at least 10 percentage points more than the 60-70% consensus.

Includes detailed discussion of strengths, weaknesses, opportunities, and threats in this area for VMware, Citrix, and Microsoft.

Virtualization enables business continuity to go mass-market.

Virtualization creates a new platform for delivering high availability and disaster recovery the way server operating systems such as Windows, Linux, or Unix or applications such as Oracle or Exchange deliver it today, but at an overall cost much lower than that of legacy solutions.

Server consolidation has led to many less critical workloads being all packed onto one highly utilized server, making that server too critical to fail. In addition, as virtualization brings down the cost of business continuity functionality, customers are beginning to deploy it far more widely than in the past.

Traditional approaches such as those from Symantec, Microsoft, and Oracle could be negatively exposed to this adverse sea change; and as a result vendors are pushing to **stay ahead of the “lower cost, good enough” alternative being developed by the likes of VMware, Citrix, and eventually a reinvented approach from Microsoft.**

Includes detailed discussion of strengths, weaknesses, opportunities and threats in this area for VMware, Citrix, Microsoft, and Symantec.

The private cloud management layer has the potential to be the most significant source of new profit pools in the virtualized data center.

A lot of ink has been spilled about cloud computing, though less has been focused on the enterprise. From a business perspective, the most fundamental transition virtualization will enable is the transformation of IT investment from something that is primarily a fixed asset to something that is primarily a variable expense. From a technical perspective applications and infrastructure get transformed into services that are delivered on-demand.

Cloud technologies in the enterprise, growing out of virtualization and service-oriented management, will enable centralized management of complex, multi-tier, composite application services running on cheap pools of commodity infrastructure. Not only will that deliver at least an order of magnitude greater IT staff productivity, but it will also democratize the most sophisticated online applications that only the biggest companies can run today, such as travel reservation or package tracking systems.

VMware and Microsoft are likely to share self-reinforcing leadership in the first key success factor **in this market. That is the ability to make a “downward looking” view of a heterogeneous collection of servers, storage, and networking look like a single machine.** Through automation interfaces, this capability redefines the economics of administering data center infrastructure.

The second key success factor **in this market is the ability to layer on an “upward looking” application service management view.** That is the critical requirement for turning an IT operation into a private cloud that can deliver rock solid online services.

VMware would have customers, ISVs, and IHVs believe it is in a two-horse race with Microsoft to deliver on this vision, since both are close to having the capabilities to make a sprawling collection of servers, storage, and networking look like a single machine.

Microsoft, however, has some natural advantages **in the “upward looking” application management view:** as the dominant server deployment platform with Windows Server, as a leading applications provider, including Exchange and SQL Server, and as a leading tools vendor with .NET, it can exert some influence in how management information is collected from applications.

However, the incumbent Big 4 systems management vendors, BMC, CA, HP, and IBM, also bring considerable service-oriented management assets to bear.

Network effects are likely to drive a self-reinforcing spiral of market share to whoever emerges as the leader over the next 3 to 4 years. That would represent a big change over today, where many best of breed vendors sell point tools for targeted needs to different buying centers. The winner in this market will be the vendor who can deliver end-to-end application and infrastructure service management.

Vendors discussed in this chapter include VMware, Citrix, Microsoft, CA, and BMC.

Virtualization is cracking open the storage industry.

The storage industry is at the cusp of the biggest structural change since networked storage began to eat into direct-attached storage a decade ago. Three developments will radically re-define the profit pools in the industry, leading to slimmer margins for all but the most innovative, software-driven players. The current recession will accelerate these developments.

First, server virtualization has the potential to mask much of the differentiation between all but the most innovative storage vendors, transferring pricing power to buyers.

Second, modular hardware is emerging at all levels but the highest end of storage in the form of commodity disks, augmented by flash memory for performance, and controllers increasingly built on commodity x86 servers. Early evidence of this trend can be seen in the erosion of hardware gross margins that has set in at some storage vendors over the last 18 months.

In response, storage vendor business models will be cracked open. What is a systems sale today becomes a separate selling motion for the software and the hardware. This will force storage vendors to sell software based on business value rather than systems based on capacity, a difficult transition for any company even in good times.

Finally, some high-growth customers, particularly online service providers, are building their own clouds. That accelerates commoditization due to the tremendous storage purchasing volume these operators aggregate as well as their tendency to rely on in-house storage management tools.

Includes detailed discussion of strengths, weaknesses, opportunities and threats in this area for VMware, EMC, NetApp, DELL, and HP.

Virtualization creates pressure on the database and middleware business.

Server virtualization upends enterprise software business models because database and middleware licensing in an on-demand virtualized world will enable customers to buy and deploy capacity "just in time" instead of "just in case." Server infrastructure software vendors including IBM, Microsoft, and Oracle are participating at varying speeds in this radical transformation.

Today, server software capacity is 'chunky' because the database and middleware licenses are typically allocated and bound to a physical box in perpetuity. In the future, customers will demand the ability to allocate additional capacity for their virtual machines on demand from their aggregate pool of license capacity. The transition to a pricing model where customers are able to pay for smaller increments of capacity in smaller increments of time will be highly disruptive to current vendor business models.

The limits of traditional static capacity allocation and licensing have created some startling anomalies. Customers repeatedly told us they forward-purchase excess capacity of three to four years per server when sizing server hardware and software

purchases. Anecdotally, we have been told this practice is true for applications such as Microsoft Exchange as well. Average Oracle database utilization per server, as measured by EMC across some of their largest customers and detailed in a presentation at VMworld 2008, is 5%. In IBM's published explanation of its virtualization-friendly pricing using sub-capacity logical partitions, it claims average database server utilization is 5-20%. All this reflects a world where moving workloads to a more powerful box was a highly disruptive exercise best avoided.

With server virtualization, capacity management becomes as trivial as moving a running database virtual machine to more processors or even to a bigger server. The flexibility that virtualization software enables for customers though has staggering economic implications for the database and middleware vendors as customers will purchase far less capacity upfront than is common today. As one Fortune 100 CIO put it succinctly, "buying minutes of capacity that can float across different physical machines fits the current economic constraints a lot better than buying perpetual capacity tied to a specific physical box."

Therefore, customers are forcing vendor licensing to accommodate not just smaller increments of capacity and time, but also to allow license mobility, thus loosening the ties to a specific physical server. As a result, licensing models will likely have to change from perpetual to a more subscription-oriented model of x amount of capacity for y amount of time. When a customer can add capacity by moving a database virtual machine to a bigger physical server for a temporary spike in demand, whether for several hours or several weeks, traditional licensing models break down.

Pricing models we see today in the cloud give an indication of the models that may come to the enterprise in the future. Microsoft's September 2008 server software licensing changes began to accommodate these new realities, offering Windows Server on Amazon Web Services for as little as 12.5 cents per instance per hour, where an instance is a virtual machine running on a slice of a physical server. When Microsoft introduced Windows Azure, they indicated that their entry-level pricing would follow the same model. However, technical challenges around measuring the amount of licenses actually consumed as well as business challenges related to vendor dependence/reliance on more fluid revenue streams create obstacles to porting the same model to the enterprise in the short term. Nonetheless, Microsoft's lead adds to the pressure on Oracle to follow. Since Oracle is the vendor with the largest share of its revenue exposed to licenses and maintenance of infrastructure software, at approximately 60% of total revenue, and is generally seen as lagging behind in its support of market-leading virtualization platforms, it has the most to lose in this transition.

In summary, customers are using the very same virtualization technology that radically improves server hardware utilization through consolidation to also improve server software utilization. This forces vendors to move closer to a subscription pricing model, which would be highly disruptive to current business models. Having upfront recognition of perpetual licenses give way to subscriptions would have a material impact on recognized revenues and reported earnings. Even if vendors were able to bill 1 or 2 years up front, the cash flow and reporting of non-GAAP earnings would still not make up the difference.

Vendors discussed in this chapter include Microsoft, Oracle, and IBM.

Spotlight on VMware, the company at the center of the storm.

VMware [announced](#) a major refresh of its server virtualization product line, renamed vSphere, on April 21. VMware vSphere 4 aims to aggregate and manage large pools of infrastructure – processors, memory, storage, and networking – as a seamless, flexible **and dynamic operating environment in what the company dubs the “mainframe of the 21st century”**. As the company’s biggest announcement in almost [3 years](#), vSphere4 marks a big step forward.

VMware **has been focused on building the “virtual datacenter” for many years, a vision it began articulating as “virtual Datacenter OS”** in late 2008. Overall, we are impressed by the product announcement, with which VMware will further expand its already considerable lead over Microsoft and Citrix. However, we suspect the company will face formidable challenges in transitioning its own sales force and particularly its channel partners towards a multi-disciplinary solutions led sale.

We believe VMware has adjusted its priorities with the arrival of a new CEO last summer. While still committed to building the vDC-OS, it appears VMware is allocating resources to desktop virtualization at a more accelerated pace. The vision VMware and Citrix have of desktop virtualization is a “user-centric” one, where an operating system-independent environment or desktop follows the user around across all her devices. Previously, users lived in a device-centric world, where data and applications were tied to individual machines. VMware is also likely to build **on this “user-centric” interaction style** and leverage “information-centric” technology that EMC acquired from Pi Corp.

VMware’s **challenge with vDC-OS** is several-fold, possibly contributing to their recent shift in emphasis towards the desktop.

- First, most of its management tools assume its hypervisor is the only platform on which they run. That deployment scenario is unlikely, even if Microsoft remains a distant second in hypervisor market share.
- Second, much of the critical technology for managing applications comes from service-oriented management platforms, which Microsoft, BMC, CA, HP, and IBM have been working on for years.
- **Third, Microsoft’s presence as a dominant deployment platform, a leading tools vendor, and a dominant server applications vendor can help tilt the management platform battle in their favor.**
- Fourth, VMware has to build credibility with, and a sales channel to, CIOs and application owners within the enterprise, not just IT infrastructure buyers.

However, VMware has a multi-year lead on Microsoft in virtualization management and it can use that time to prepare for the competition that has gotten less attention, the one with Citrix over the desktop.

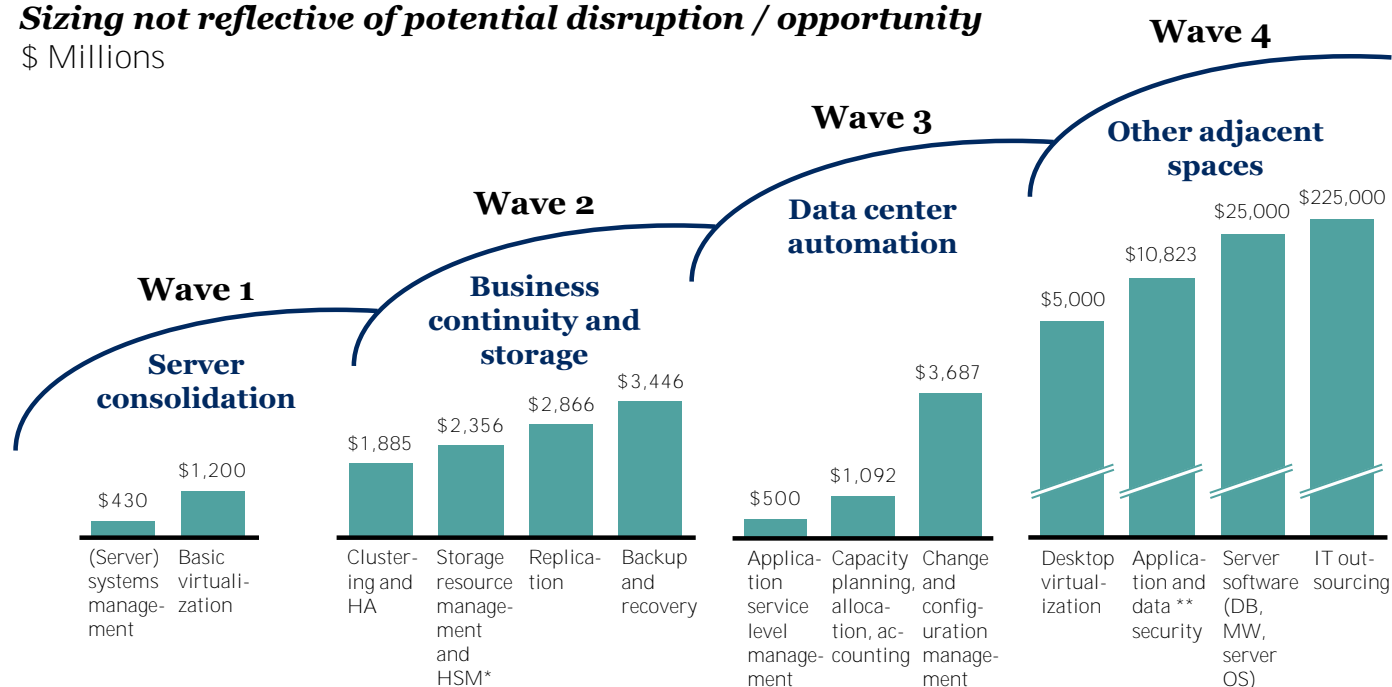
Overall, our report illustrates that server virtualization will have ripple effects that extend much beyond the current market consensus. How much of that ripple will be a disruption of existing markets vs. creation of new markets will be of vital importance to customers, vendors and investors.

Server virtualization affects many markets much beyond the current hypervisor vendors

Market size – 2008

Sizing not reflective of potential disruption / opportunity

\$ Millions



How much of the impact of virtualization will be a disruption of existing markets vs. creation of new markets will be of vital importance to customers, vendors and investors

* Hierarchical storage management/archiving

** \$8,278 million secure content management (web, email), \$2,545 million security and vulnerability management

Source: TechAlpha analysis based on IDC data

Methodology

Findings from our report draw upon the following:

- In-depth interviews of 30 Fortune 500 CIOs and VPs of Infrastructure;
- Quantitative validation of findings with 175 IT executives;
- Thorough discussions with CTOs and VPs of product management at key vendors, including VMware, Citrix, Microsoft, Symantec, CommVault, EMC, NetApp, IBM, BMC, CA, as well as Infosys, Satyam, Wipro, Tata, and several emerging technology players.

Out of Scope Topics

Markets that are not the primary focus of this report:

- Desktop virtualization;
- Cloud computing;
- Server hardware;
- Security;
- IT Services.

II. Critical Perspective on the VMware vSphere Announcement

Key Takeaways

VMware [announced](#) a major refresh of its server virtualization product line, renamed vSphere, on April 21. VMware vSphere 4 aims to aggregate and manage large pools of infrastructure – processors, memory, storage, and networking – as a seamless, flexible and dynamic operating environment in what the company dubs the “mainframe of the 21st century”. As the company’s biggest announcement in almost [3 years](#), vSphere marks a big step forward and is focused on three objectives:

It makes major strides in removing the barriers that slow the advance of virtualization into more performance-sensitive, business critical workloads such as SQL Server, Exchange or SAP. For instance, we estimate that less than 5% of SAP production workloads running on x86 hardware are virtualized today, unlike test & development workloads which are widely virtualized already. That explains the primary focus on increased performance and scalability. Based on our primary research with customers and channel partners, we believe that virtualization may be reaching an inflection point as far as adoption for more business critical production workloads is concerned.

The secondary focus is on storage efficiency and energy efficiency, which should **resonate in today’s environment where CFOs have a much more prominent role at the table** in IT buying decisions. In principle, this should lead to reduced capex and opex associated with VMware deployments.

Finally, there is a focus on automated resource management and simplified operations. This is most relevant to large virtualized environments, say 50 physical servers and up. **While it’s positioned to reduce the 70% of IT budgets being spent on keeping the lights on**, frankly, it reinforces the functionality of other parts of the suite in mitigating the challenges of virtual server sprawl.

Not a complete story yet on private cloud.

The company catches the marketing zeitgeist by labeling its suite “the industry’s first operating system for building the internal cloud”. VMware correctly recognizes that private clouds are coming before public clouds, and that these will only be successful if they enable mainstream commercial workloads to be run in these clouds without requiring modifications. The company claims that “for hosting service providers, VMware vSphere 4 will enable a more economic and efficient path to delivering cloud services that are compatible with customers’ internal cloud infrastructures.”

While VMware is by far best positioned among all vendors to enable these private clouds at the infrastructure level, and is building that stack from the bottom up, we would have liked to see more detail on what that top-to-bottom private cloud stack would look like. Gregory Smith at T-Systems [articulated very well](#) at this week’s SAP Virtualization Week **what’s required for a true private cloud that provides infrastructure-as-a-service** to enable end-to-end application services delivery. VMware is currently focused on virtual

infrastructure as a delivery platform and clearly parts of that stack are still missing, such as the ability to charge back internal departments based on usage. Moreover, vSphere 4 **seems limited to “puddles not pools” in that it maxes out at 32 physical servers** that are put into a single logical resource pool.

We would imagine that service providers lacking the scale of a T-Systems would look to VMware to provide more of a packaged cloud solution that would enable them to offer their customers a private cloud out of the box. Clearly that is a much more complex story to articulate given the general customer confusion around the topic coupled with the complexity of the stack required to make that work, which may be why there is no further detail at this point.

The company did not talk about its desktop virtualization product line, renamed View. Since View is based on the newly refreshed server virtualization infrastructure, we would expect to see a refresh towards the end of the year. For users accessing a desktop environment streamed from servers, the storage efficiency will go a long way to bring capex costs down toward traditional desktop environments. Better presentation protocols, including the one coming from the [joint work](#) with [Teradici](#), will **bring Adobe Flash and other rich media support to end users. What’s not clear yet is** when the client-side bare metal hypervisor that works in occasionally-connected environments will finally ship. However, many of our interviewees did say that given **VMware’s advantage in managing servers, their customers expect to use that same** infrastructure to manage their desktops, when and if they start that migration.

The company didn’t emphasize its previous aspirations of application-level end-to-end data center management. The company will ship an upgrade to its highly regarded AppSpeed application performance management product. However, it will only provide application-level intelligence for a limited number of workloads, including J2EE frameworks, .NET, SQL Server, and a few others. We believe VMware is leaving the application-level management to others because the company did not want to compete head-on against Microsoft and the Big Four systems management vendors. Moreover, most customers prefer to have their existing tools management as much as possible across physical and virtual infrastructures.

Overall, we are impressed by the product announcement, with which VMware will further expand its already considerable lead over Microsoft and Citrix. However, we suspect the company will face formidable challenges in transitioning its own sales force and particularly its channel partners towards a multi-disciplinary solutions led sale.

The following sections will expand on key product and competitor takeaways as well as the challenges we see on the horizon.

Competitors

Citrix:

We struggle to find many sizable, satisfied enterprise production deployments of XenServer. We see Citrix' recent decision to make XenServer free, see [here](#) and [here](#), as an admission that XenServer was not getting much **traction and wouldn't be surprised if Citrix started to write their Essentials product line primarily for Microsoft's Hyper-V**, thus reducing investment in XenServer.

While the real battle with VMware will be over the desktop, we have become incrementally **more skeptical of Citrix' ability to pull this off since desktop virtualization** relies on the server virtualization back-end stack. Customers and partners told us they would be unlikely to deploy Citrix server infrastructure management to manage desktops if they already had VMware server infrastructure. Moreover, Citrix is still lacking credibility with mainstream server infrastructure buyers due to the desktop focus of current channel partners and sales force.

Microsoft:

The axis of competition with VMware seems today to be primarily price-based. Competition will intensify as higher-value, high availability **features migrate to a "cheap SKU" which we expect Microsoft to introduce in CYH2 2009.**

However, VMware has put a lot of effort into removing the price umbrella that has been **exposed to Microsoft. VMware has strengthened its family of SKUs aimed at SMB's** by providing high availability and data protection at affordable price points. For instance, the entry level ESXi costs \$995 for 6 CPUs with basic management and per incident support. The Essentials SKU costs \$2995 for 3 servers of 1 socket and 8 cores each or 20 VMs with the graphical management console vCenter plus high availability and data recovery.

While it is true that Microsoft bundles Hyper-V for free with most editions of Windows **Server 2008, this drives a significant mix shift in customers' purchases of Windows** Server 2008 in favor of the highest-priced Data Center edition. In particular, the Standard edition only accommodates one virtual machine per host, while the Enterprise edition accommodates the host plus four virtual machines, and the Data Center edition accommodates an unlimited number of virtual machines.

All **Microsoft's Hyper-V** SKUs currently have severe limitations such as memory, clustering, and the absence of migration. We expect these constraints to be relaxed when Windows Server 2008 R2 will be released. In particular, we expect Microsoft to release a Hyper-V standalone SKU at a nominal cost that contains these features (enabling high availability and live migration) and maps to the Windows Server Enterprise Edition.

Overall, the VMware announcement clearly increases the multi-year lead that VMware already enjoys over Microsoft. Microsoft will continue to remain well behind VMware in the size of resource pools it can put together as each continues to move forward. We do

not expect that enterprises will make Hyper-V their virtualization standard of choice because of performance, scalability, and resource management limitations. However, we would expect Microsoft to evolve into a formidable competitor in data center automation in 3 to 5 years since they can leverage their considerable assets and ongoing investment in systems management independent of their virtualization effort to compete with VMware (and others) in data center automation market.

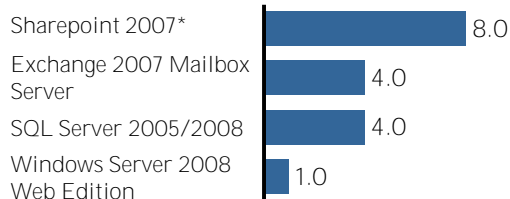
Product Highlights

Performance and scalability: The company claims improved scalability and performance with reduced virtualization overhead for more business critical applications. One interviewee put the total system cost per virtual machine (presumably excluding VMware licensing) for business critical workloads at \$4,000-6,000 per VM prior, and stated this could now be as low as \$1,000-1,500 per VM. Moreover, the company claims vSphere enables close to or better than native performance for the many applications that are not written to take advantage of multiple processors. This may be true for workloads that run alone on an ESX host. For servers with rapidly increasing core counts, running more VMs per ESX host helps maintain high utilization **despite applications' inability to scale up.** Rapid advances in hardware performance will force customers to virtualize more applications than currently anticipated or risk underutilizing servers. Many popular applications are only using 4 cores today in typical or recommended configurations, while the average number of cores per server is growing at a much more rapid pace.

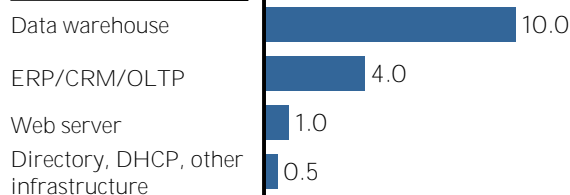
Rapid advances in hardware performance will force customers to virtualize more applications than currently anticipated or risk underutilizing servers

Many popular applications are only using 4 cores today in typical or recommended configurations

Microsoft workloads



Other workloads



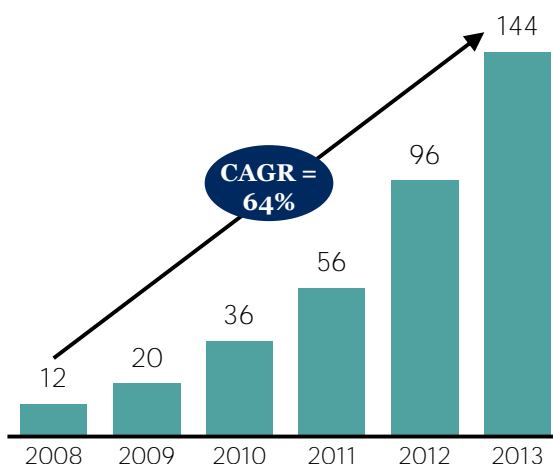
* 2 cores for Web Server role; 2 cores for app server; 4 cores for SQL database server

** Supports 32 cores in x86 and 64 cores in x64 mode

*** Typically consuming 0.5 cores per workload

Source: TechAlpha analysis

Average number of cores per server is growing at a rapid pace based on growth in cores per socket and sockets per server

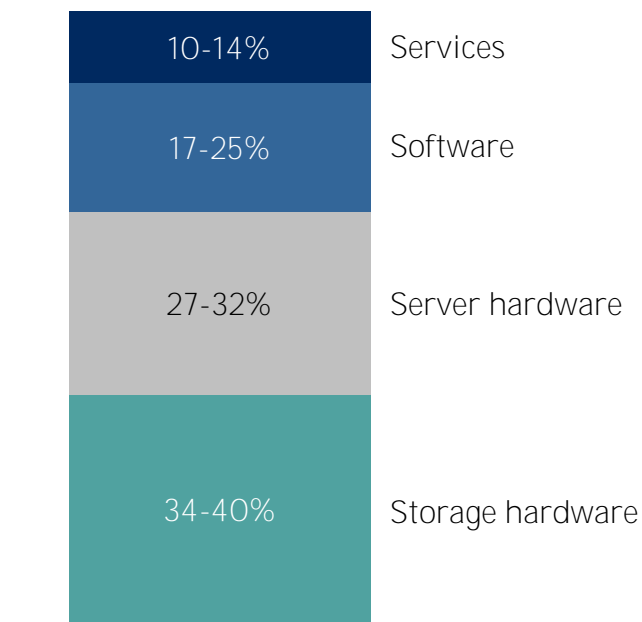


Storage efficiency: The company claims “up to 50 percent storage savings with VMware vStorage Thin Provisioning”. That is very important in the current budget-constrained environment: Storage hardware accounts for the single biggest share – 35 to 40% - of virtualization project capex. According to our own poll of 200 customers, more than half of storage capex is directly driven by virtualization. What the company is not addressing though are storage-related shortcomings that are intrinsic to VMFS (the VMware File System, on which many advanced features depend). Notably, VMFS maxes out at 32 node clusters (i.e., limiting the size of the resource pool) and is only able to lock / share a full VMDK file as opposed to more granular blocks within it. The latter would be very valuable for improved data management. (We believe, however, that the Microsoft equivalent with Windows Server 2008 Release 2 is still much more limited in terms of max node count.)

Storage accounts for the single biggest share of virtualization project capex

Typical VMware server consolidation project

100% = \$44,000-62,000

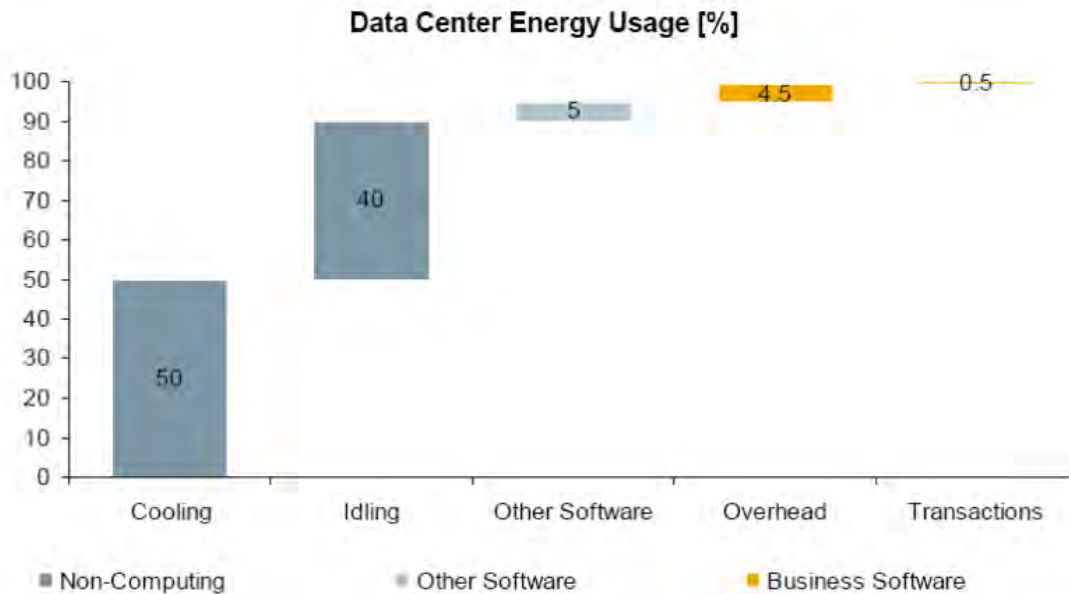


Source: TechAlpha analysis based on VMWorld interviews

Energy efficiency: Distributed Power Management (DPM) goes from ‘experimental’ to ‘general availability’ stage. The product consolidates VMs on as few servers as necessary, and powers down the servers that are not used. The company claims “up to 20 percent additional power and cooling savings”. Clearly this is very relevant: according to Peter Graf, SAP’s Chief Sustainability Officer, 40% of data center energy usage is ‘idling’, and 50% is ‘cooling’, so DPM means less idle servers and hence less cooling. (Do any readers know though how frequent power on/off might reduce server lifespan? [Contact me.](#))

Only 0.5% of Energy Used for Transactions

SAP



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Source: McKinsey, 2008

Fault tolerance: The company announced VMware Fault Tolerance, which provides zero downtime and zero data loss without the need for complex clustering or special hardware. Fault tolerance relies on two VMs running in lockstep on separate hosts, with a heartbeat, and works on top of VMware's High Availability technology.

Unlike VMware High Availability, which entails 3-4 minutes of downtime while a virtual machine is restarted on a new server and is relevant for 80% of applications, Fault Tolerance runs a shadow VM on the second host, thus offering continuous data protection. We believe this could ultimately expand the market from the ~5% of applications that take advantage of legacy high cost fault tolerance to more like ~30% that could take advantage of the simpler, more elegant VMware approach. The first release is limited to a single CPU running in a single VM. We have heard it may also be limited to 64-bit hardware only. The likely sweet spot is in custom applications built for a single (clustered) server (e.g., 911 dispatch), though one interviewee indicated comfort around putting SQL and the Exchange Message Server onto the solution as well.

Overall, this is very valuable functionality as it makes previously very high-end, expensive and complex functionality truly accessible. It is a strong counter to the high

availability functionality that Citrix offers in conjunction with their technology partner Marathon. In fact, Citrix and Marathon just announced their own fault tolerance product which does not appear to have the same restrictive performance limitations.

Go-To-Market and Challenges Ahead

Channel

VMware becomes more and more of a complex ecosystem sale, as virtualization deployments generate lots of downstream revenue notably for storage and networking partners, and to a lesser extent for security and business applications channel partners. That drag should be increasing as the company penetrates more business critical workloads and as partners build out more of a solutions and services-rich sales capability. Our sources indicate the drag stands at around \$10 of ecosystem revenue for every \$1 of VMware license revenue. That should make VMware attractive to partners, but may also ultimately prove a burden to customers.

Possibly the company's biggest challenge will be to master the transition to a services-rich, solutions-led sale. Unlike other technology vendors who have gone down this path before, though, executing on its vision will require a joint sale across different practices of a channel partner, e.g., storage, networking, business applications, virtualization, or possibly collaboration by channel partners across these different specialties.

While channel partners we interviewed were clearly excited about what's on offer, we suspect many will need some time to get ready to position, close, and deliver on virtualization solutions in more business critical settings, which will include building out more of a consulting / professional services capability.

Pricing

The new packaging and pricing stretches the price bands at the low end and high end, incorporates a wide range of new features across the various tiers, and increases clarity around which solutions/use cases correspond to which tier. In particular, the company positions its Standard price tier for consolidation use cases, Advanced for availability, Enterprise for automated resource management, and Enterprise Plus for simplified operations (in fact an up-sell from the existing highest price points).

As you would expect, VMware is adding functionality to SKUs at every price level. In other words, there is a cascading pricing waterfall that brings previously higher-priced functionality down to lower price levels, while most of the truly new functionality gets added at the higher price bands. Our quick initial take is that while the pricing formula shifts from pricing per two processors to pricing per single processor, pricing for the **bulk of VMware's** existing customers, 85% of whom tended to buy the most expensive SKU, seems to remain broadly unchanged (not counting the richer functionality spread across all levels). The new low end pricing incl. added feature set will make the company more competitive with Microsoft Hyper-V, but we see no real risk of this cannibalizing the enterprise business.

III. Server Virtualization Wave 1 – Server Consolidation

Key vendor takeaways

The penetration rate for server consolidation is likely to reach at least 10 percentage points higher than the 60-70% consensus forecast, positively impacting VMware despite increased competition from Microsoft.

While virtualization prices for basic consolidation functionality per CPU or server are coming down, more servers than expected will be required because consolidation ratios are going down with the increasing importance and performance sensitivity of the new workloads. However, growth rates for consolidating newer applications will be materially slower because a new “customer” is involved.

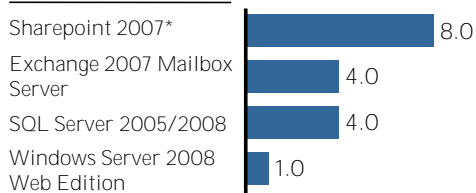
Rapid advances in server hardware performance will force customers to virtualize more applications than currently anticipated.

The exhibit below shows the disconnect between rapidly increasing mainstream server capacity in terms of processor cores per server relative to the number of cores that software can exploit. This will likely force customers to virtualize more applications or risk dramatically underutilizing servers again, ultimately expanding the penetration rate.

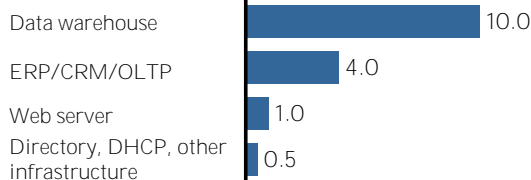
Rapid advances in hardware performance will force customers to virtualize more applications than currently anticipated or risk underutilizing servers

Many popular applications are only using 4 cores today in typical or recommended configurations

Microsoft workloads



Other workloads



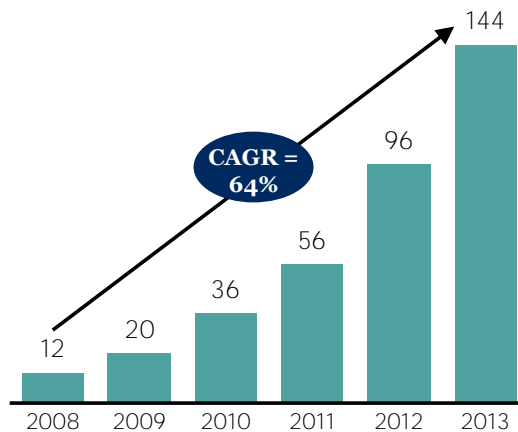
* 2 cores for Web Server role; 2 cores for app server; 4 cores for SQL database server

** Supports 32 cores in x86 and 64 cores in x64 mode

*** Typically consuming 0.5 cores per workload

Source: TechAlpha analysis

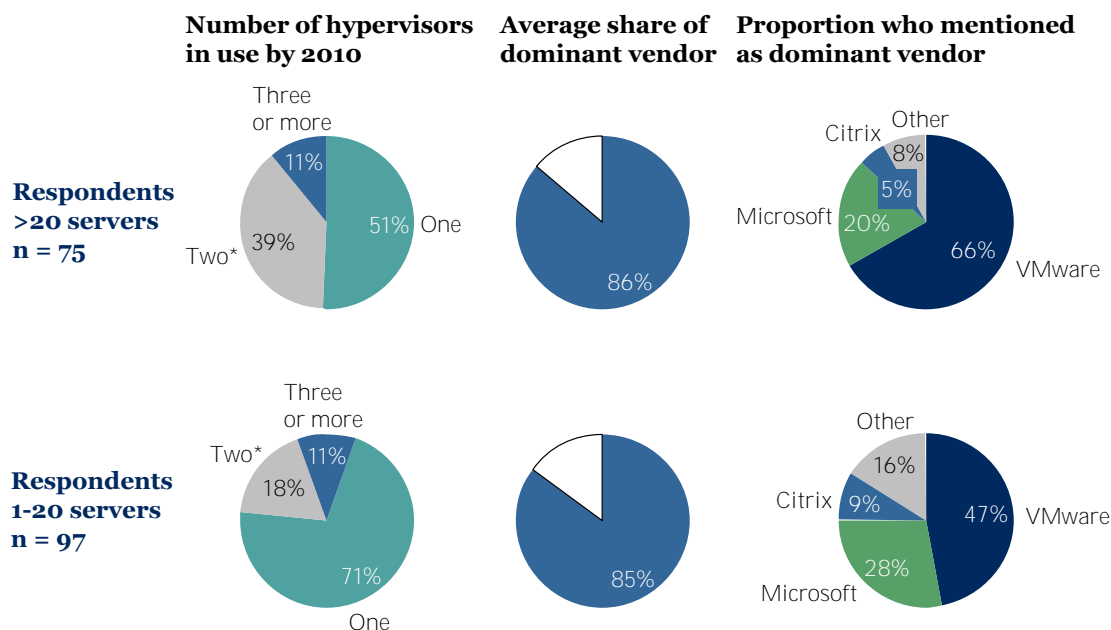
Average number of cores per server is growing at a rapid pace based on growth in cores per socket and sockets per server



We expect VMware to maintain its dominance among enterprise and upper mid-market customers for the next 2 to 3 years

Microsoft is likely to become a formidable competitor first in the SMB space and will also be used by customers to keep pricing pressure on VMware.

Survey suggests there is space for two hypervisor vendors, with Microsoft outrunning Citrix by a wide margin for the #2 spot



* Includes respondents who stated two hypervisors will account for 95% or more of all virtualized servers

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

Key controversies

Hasn't Microsoft commoditized server consolidation with a combination of Windows Server 2008 and Hyper-V?

Microsoft has shipped a credible product and anecdotal evidence of uptake in Q4 2008 is very encouraging.

Our survey confirms Microsoft as the clear #2 player with about twice the mindshare of Citrix. We would not be surprised to see strong unit share gains once IDC's Q4 virtualization tracker data are released. It should be noted, however, that a large percent of the unit share in the market is comprised of free versions of both the Microsoft and VMware hypervisors which are typically used for evaluation and pilots.

Contrary to the perception of "free" though, virtualization drives considerable spend for customers.

Currently Microsoft's "free" standalone Hyper-V SKU is used mostly for consolidation and being able to run older versions of Microsoft products, notably Exchange and SQL Server, on hardware that runs Windows Server 2008 without compatibility issues.

While it is true that Microsoft bundles Hyper-V for free with most editions of Windows Server 2008, this drives a significant mix shift in **customers' purchases of Windows Server 2008** in favor of the highest-priced Data Center edition to take full advantage of the virtualization functionality. In particular, the Standard edition only accommodates one virtual machine per host, while the Enterprise edition accommodates the host plus four virtual machines, and the Data Center edition accommodates an unlimited number of virtual machines.

On a similar note, management functionality can add significantly to the base price. This explains why 85-90% of VMware ESX licenses are sold at the highest, \$5,000 price point. When customers put more applications on a server and begin to virtualize more business critical applications, the value proposition begins to include additional functionality that enables management of planned and, eventually, unplanned downtime.

Competition with VMware seems intense today with discounting common. Competition will intensify as higher-value **features migrate to a "cheap SKU"** which we expect Microsoft to introduce in CYH2 2009.

Microsoft's Hyper-V standalone SKU has limitations such as memory, clustering, and the absence of migration that align with the Windows Server Standard SKU limitations.

All three of these limitations will be removed when Windows Server 2008 R2 will be released. In particular, we expect Microsoft to release a Hyper-V standalone SKU at a nominal cost that contains these features (enabling high availability and live migration) and maps to the Windows Server Enterprise Edition.

This might force VMware to respond by leading with its lower price SKUs and then up-sell, a major reversal from its current GTM strategy. Anecdotally, customers report aggressive discounting by VMware across the board after Microsoft entered the market. One example we heard was a VDI (desktop virtualization) deal for 40k desktops at a list price of \$150 per user that was discounted down to \$40.

Isn't rapidly increasing server price performance driving ongoing effective price deflation?

The short answer is not that dramatically. VMware currently prices its software for two CPU sockets with up to six cores per socket. Microsoft and Citrix charge by servers. VMware is maintaining enough differentiation around planned and unplanned maintenance functionality to maintain its dual socket pricing model. However, the average price per dual socket is coming down as competition shifts some of the functionality currently at the high end of the product line to lower tiers.

Market dynamics

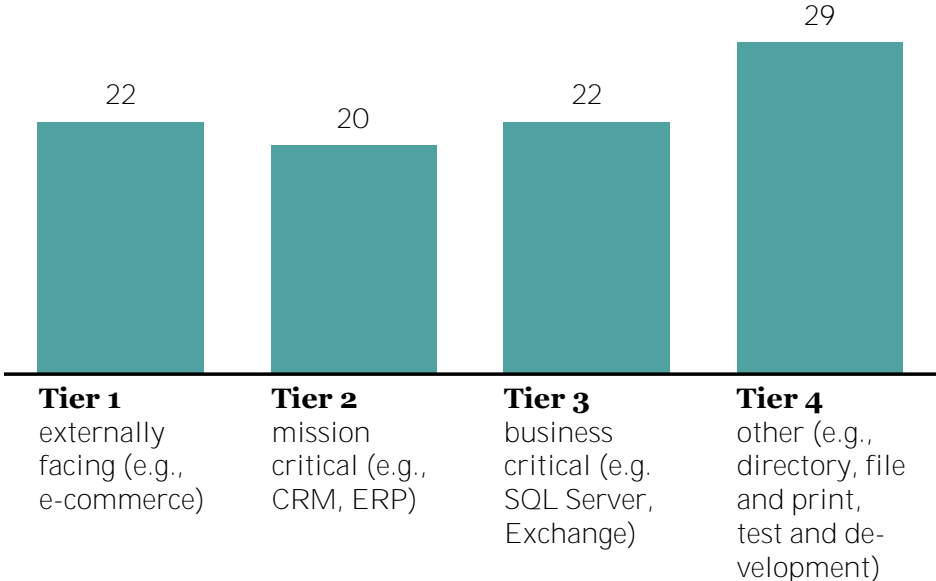
Market overview

The penetration rate for server consolidation is likely to reach at least 10 percentage points greater than the 60-70% consensus forecast, positively impacting VMware despite increased competition from MSFT.

Customers expect to go beyond simple test and development and infrastructure workloads such as file and print, networking, systems management, and workgroup sharing such as Sharepoint. Although they are only beginning to test more business critical and performance-sensitive workloads, they expect to take advantage of functionality that helps them manage planned and, eventually, unplanned downtime.

The survey affirms consensus expectations of virtualization penetration ‘in the twenties’

What percentage of your total workloads (e.g., application instances) are virtualized today?



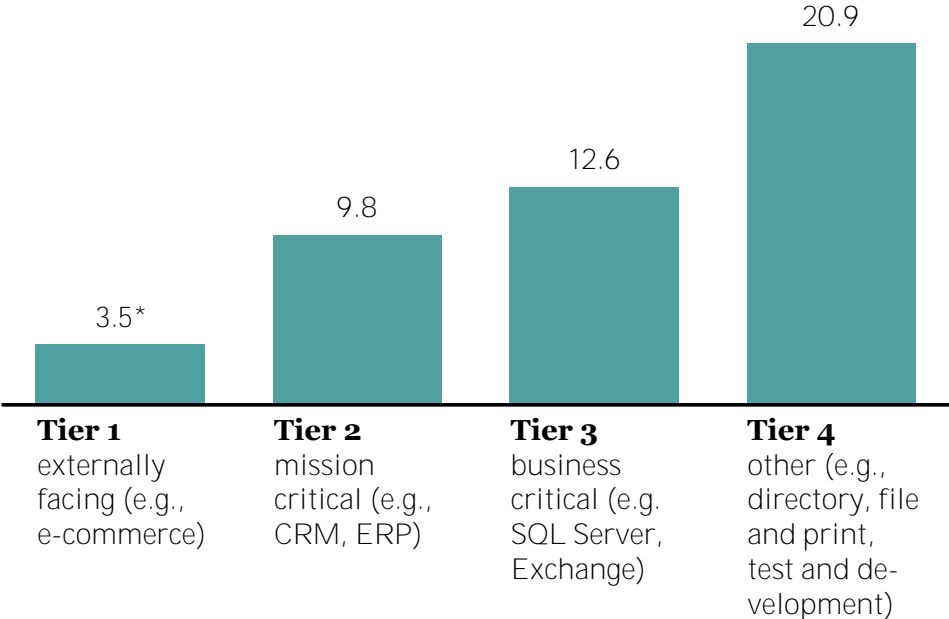
Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

As the exhibit suggests, although lower-tier, non-critical workloads were the first to be consolidated and are the most numerous, customers plan to virtualize more than the consensus estimates for reasons that start with managing planned and unplanned downtime.

While virtualization prices for basic consolidation functionality per CPU or per server are coming down, more servers than expected will be required because consolidation ratios are going down with the increasing importance and performance sensitivity of the new workloads.

Compression ratios decrease with application criticality

How many workloads will you be running in 2009 per virtualized server?



* Survey data complemented by interviews
 Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

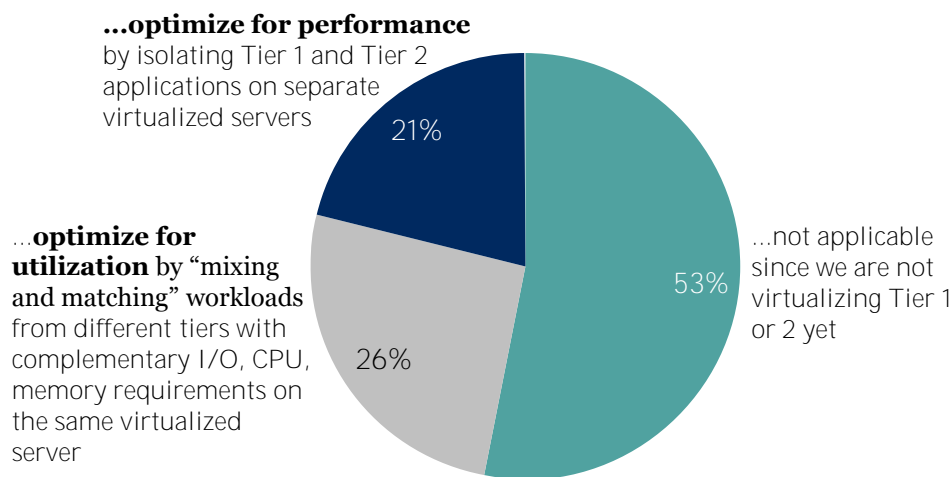
Consolidation ratios are trending materially lower, as low as 3-4:1 for the tentative tests with the few, newer, business critical workloads vs. 10-20:1 for test and development and Tier 3 apps previously. This is partly because their performance demands are greater, and partly because customers are more tentative about stacking up applications that have a greater business impact. Higher utilization rates leave less room for spikes in demand, which would be immediately visible to the application administrators and end users. In other words, for these new applications, the price per virtualized workload is trending up, not down, since pricing is based in terms of servers or CPUs.

It should be noted that some customers mix and match the less critical infrastructure and Tier 3 workloads with the more sensitive Tier 2 workloads on the same server to get a more balanced overall resource consumption profile. In other words, they may not want two databases on the same server because they both would hog bandwidth to memory, the network, or storage. However customers configure servers for the more critical apps, whether mix and match or cordon them off, there will be fewer workloads per server or CPU, creating upward pressure on the effective virtualization license cost per workload.

Respondents seem cautious about the impact of virtualization on Tier 1 and Tier 2 workloads

To the extent that you are already virtualizing Tier 1 and Tier 2 workloads, are you more likely to...?

100% = 121



As application owner comfort with virtualization grows, we expect to see more “mix and match” to optimize aggregate utilization

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

For the next phase of server consolidation and virtualization, customers’ ability to optimize for utilization and hence ROI will critically depend on the availability and adoption of advanced management tools that tie intelligent storage I/O into a policy oriented data center management framework. Higher server consolidation ratios imply tier 1 apps and heavier I/O apps will be virtualized. **Brocade’s Server Application Optimization** products for instance enable Quality-of-Service (QoS), in particular for demanding Tier 1 or for mixed workloads, by encapsulating and isolating the server-to-storage connection in a virtual channel. **Brocade’s** application-to-data QoS extends from the virtual server vport to the storage port facing the storage array. Its product isolates potentially errant server apps/VMs from interfering with each other on shared Fibre Channel protocol links.

However, growth rates for consolidating newer applications will be materially slower because a new “customer” is involved.

Citrix and VMware, but VMware in particular, have to cultivate the application owners now, in addition to their historical infrastructure buyer. Both vendors have sold platforms that manage infrastructure, whether file and print servers or test and development servers in VMware's case or remote desktops in Citrix's case. Except in the minority of cases, neither provided full virtualization for mainstream applications such as SQL Server, Exchange, or line-of-business applications. When those applications are involved in virtualization, the application owner has to sign off on the use of a new platform, and they take time before they get comfortable with a new platform.

In addition, virtualization vendors have to make progress on two fronts: minimizing the lingering “performance tax” or overhead of the hypervisor, and cultivating ISV support. Some holdout ISVs, notably Oracle, have to certify they will support and license their products for 3rd party virtualization platforms.

Rapidly increasing mainstream server capacity in terms of CPU sockets and cores per socket is likely to force customers to virtualize more applications or risk dramatically underutilizing servers again, ultimately expanding the penetration rate.

As shown in the exhibit at the beginning of this chapter, server capacity in terms of number of processor cores per server is increasing faster than server applications such as middleware, databases, and enterprise applications can exploit them. Short of running applications on servers with only fractional capacity, they will need to use virtualized servers as shared resources eventually.

Mainstream software is having more and more trouble exploiting or consuming the capacity of mainstream servers. Servers used to get faster every year as measured by gigahertz, which software could consume without any modification. Once servers began hitting a wall in terms of heat dissipation, they could no longer add capacity in terms of speed, but instead added performance in more cores (or CPUs) per chip and sometimes more chips per server.

While mainstream servers are supplying ever more cores or CPUs, mainstream server software is not expanding its ability to consume them anywhere near fast enough. The main reason software products cannot scale up to the new server levels is because rewriting software to run in a highly parallel, multi-CPU environment is extremely difficult. Typically, it takes years to become highly parallel, if it is possible at all, without help from development tools and the underlying operating system.

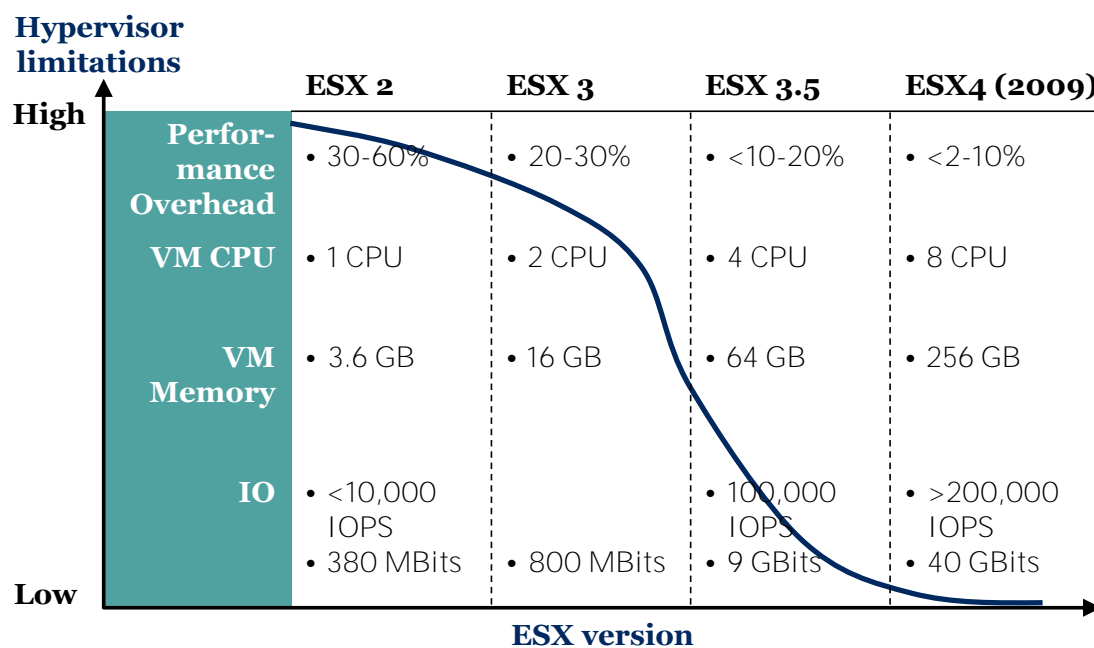
As a result of this software/hardware disconnect, hypervisors from virtualization vendors make it possible to run multiple applications on the same server, each of which consumes some of the available cores or CPUs. In other words, even if customers originally virtualized only test and development and basic infrastructure, the evolution in servers is introducing a powerful force to drive virtualization deployment into higher-tier, more critical workloads.

Server consolidation is merely an entry point to a steadily richer follow-on set of capabilities from VMware, Citrix, Microsoft and eventually others.

Consolidating servers, as most already understand, starts with the least important/critical workloads and moves higher as customers gain confidence and trust in the technology. Our research, based on a combination of surveys of SMBs and interviews with enterprises, indicates that the consolidation ratio is trending down from 10-20:1 for test and development workloads to 3-4:1 for Tier 2 workloads. The reason customers continue to consolidate higher tier workloads becomes less and less about hardware utilization and more about follow-on capabilities, such as managing planned downtime (Live VMotion) and unplanned downtime (High Availability and Disaster Recovery – see next chapter).

Finally, it should be noted that virtualization has addressed some of the initial use case concerns and limitations. In particular, the performance overhead will all but disappear shortly and this may be further cemented by additional assistance from the microprocessor (i.e., chip-based implementations).

More than 95% of applications match or exceed native performance on VMware infrastructure

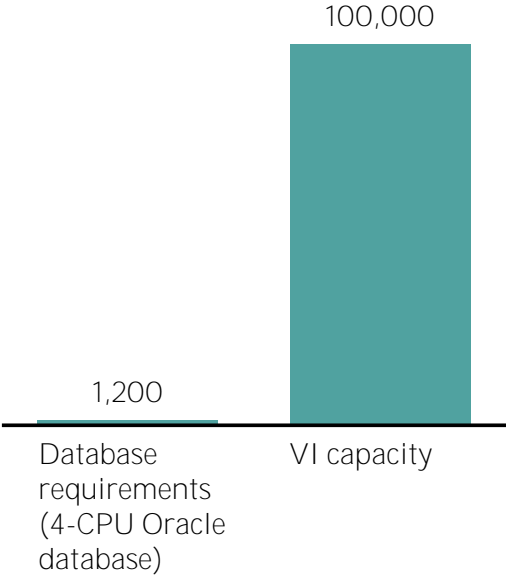


Source: Adapted from VMware

VI supports 80X the IO throughput requirement of the average 4-CPU Oracle database

Database requirements vs. VI performance

Disk IO per second

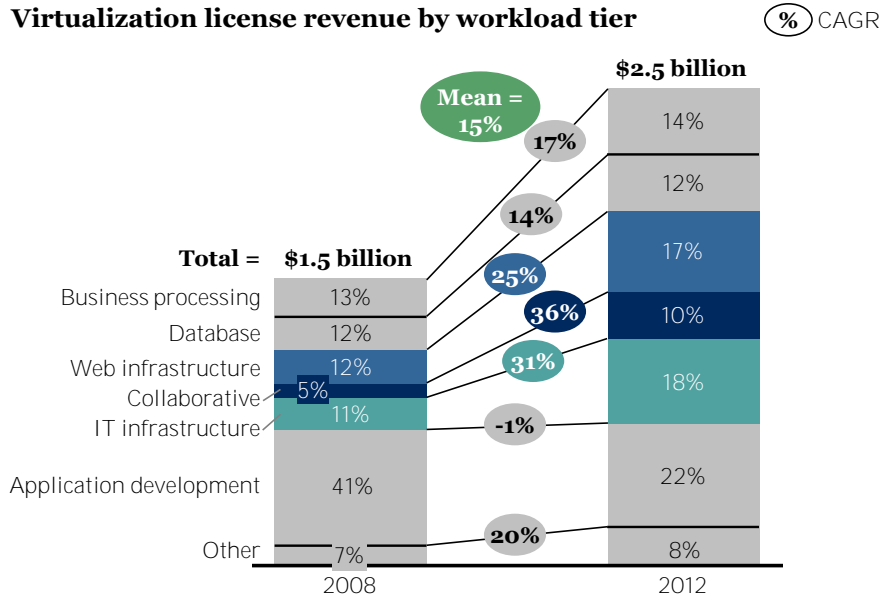


Source: VMware Capacity Planner analysis of >700,000 servers in customer production environments

Market size and growth

Virtualization is starting to move into Tiers 2 and 3 workloads, notably Web infrastructure, collaboration, and IT infrastructure.

Virtualization is moving into Tier 2 and Tier 3 workloads



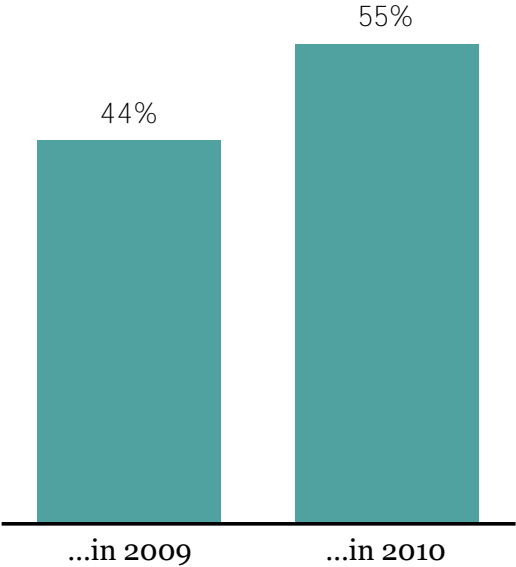
Note: Workload definitions: **Business processing** – ERP, CRM, OLTP, Batch; **Database** – database; **Web infrastructure** – Streaming Media, Web Serving; **Collaborative** – E-Mail, Workgroup; **IT infrastructure** – File & Print, Networking, Proxy/Caching, Security, Systems Management; **Application development** – Test & Development; **Other** – Decision Support (Data Warehousing/Mart, Data Analysis/Mining), VDI, Technical, Industrial R&D

Source: TechAlpha analysis based on IDC data

Respondents expect that more than half of newly deployed servers will be virtualized within a year.

Respondents expect to virtualize one out of every two new physical servers within a year

What proportion of your newly deployed x86 servers will be virtualized...?

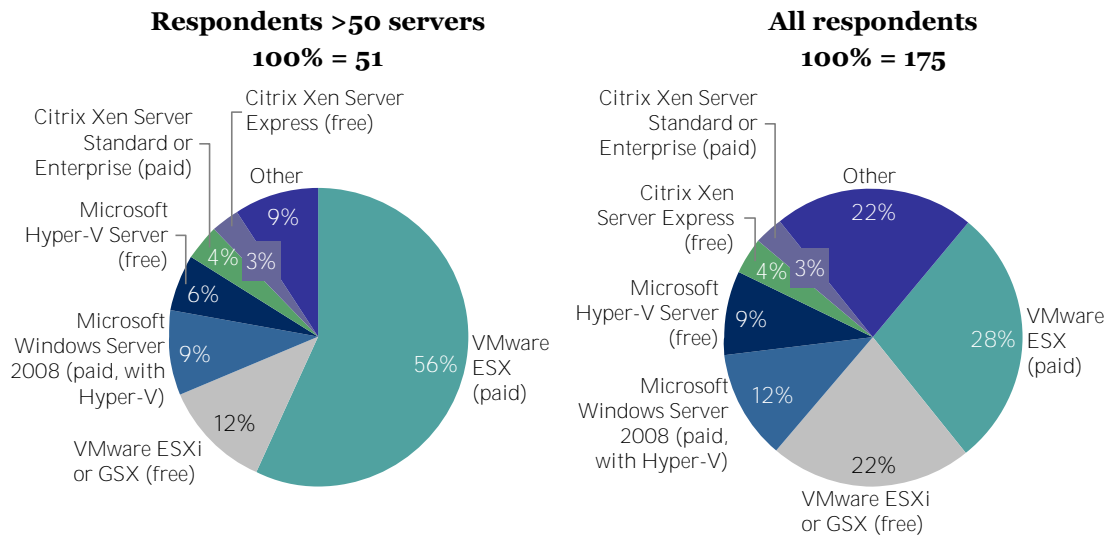


Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

VMware continues to be the share leader and well positioned to defend its lead over the next 2 years.

VMware enjoys a two third market share by volume among enterprise respondents

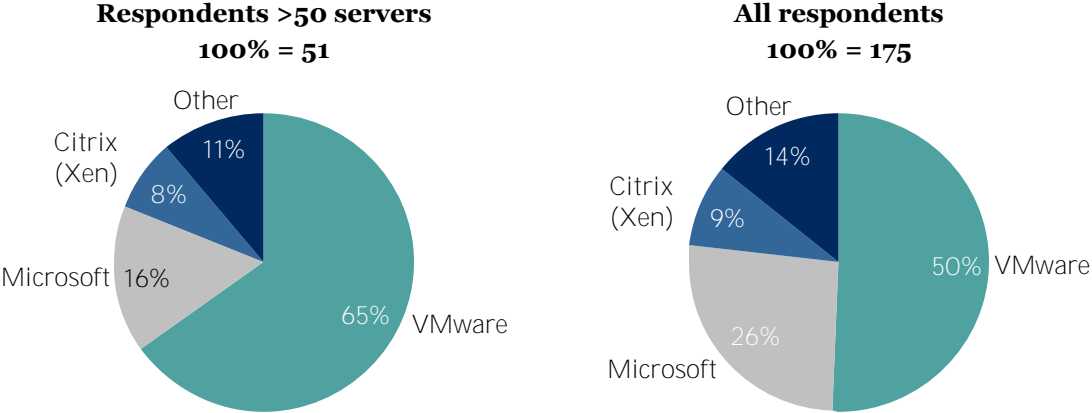
What percentage of x86 servers that you virtualized in 2008 run the following hypervisors?



Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

VMware seems poised to defend its unit share among enterprise respondents into 2010

What percentage of x86 servers that you plan to virtualize in 2010 will run server virtualization software by...?



Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

SWOT for VMW

Strengths: Overwhelming leader in revenue share and enterprise deployments. Well-developed channel and multi-year lead on Microsoft in maturity, performance of hypervisor.

Weaknesses: Still depends for a material share of revenue on basic functionality that Microsoft is trying to commoditize. Needs to earn credibility with and build channel to application owners and ultimately CIOs to sell future functionality. This erosion in price and the tail-off in shipments for server consolidation is what we believe concerns many investors in VMware. The most important takeaway, however, is that virtualization is a platform for follow-on functionality that either keeps prices from eroding as fast or actually pushes prices higher over time, depending on how the platforms evolve and how well they are accepted.

Opportunities: Has couple year lead in building and selling HA/DR functionality. Can also move in a direction Microsoft does not want to go in offering user-centric, occasionally-connected, operating system-independent virtualized desktops.

Threats: As more advanced management functionality gets built on top of the hypervisor, it will be easier for Microsoft to leverage non-virtualization-related assets that it has been developing for some time.

Perspective on VMware:

Major product cycle expected to ship in May could provide catalyst

What's new

- ESX 4 and VI4, renamed vSphere, expected to be announced 4/15 and to ship in early May
- Expect VMware to reposition this as a 3+ year lead over Microsoft's upcoming Windows Server 2008 R2 and Citrix's current XenServer and Essentials management offerings
 - Increased scalability: Able to treat up to 64 machines as a single cluster
 - Increased performance: per virtual machine, supports 8 CPUs (prior: 4), 256 GB of memory (prior: 64), networking at 40 GB/s (prior: 9) and 200k IOPS (prior: 100k)
- vSphere (virtual data center operating system)
 - Key differentiator: forms the foundation of private clouds / next-gen mainframe based on pools of server, storage, and networking infrastructure
 - Will position Microsoft R2 and current Citrix products as merely enabling hypervisors to communicate with each other
 - Not publicly de-emphasizing management effort, but we believe VMware no longer has pretensions or desire to compete head-on with full Microsoft Systems Center family, CA, BMC, HP, IBM

What to watch for

- Early indications that mission- and business-critical application are being virtualized
 - For instance, currently only 2-5% of SAP production instances
 - Virtualization performance overhead still an issue
 - Oracle Fusion middleware later in 2009 likely to be more virtualization friendly
- How much value is placed on management functionality
 - Is VMware app-agnostic 80/20 approach good enough for customers?

SWOT for CTXS

Strengths: Owns 1 million XenApp Servers (Presentation Server) that its channel partners can sell Xen Server with HA/DR into. Based on our research, we believe their HA functionality, offered in conjunction with their technology partner Marathon Technologies, is actually more advanced than VMware's **for some use cases**.

Weaknesses: Lacking credibility with mainstream server infrastructure buyers due to focus of current channel partners and sales force.

Opportunities: Can leverage their server virtualization management tools and desktop presentation technologies for inside track on multi-billion dollar desktop virtualization market that should take off over next 12 to 24 months.

Threats: May be marginalized on server opportunity because of combination of limited channel to infrastructure buyer and limited opportunity to add competitive footprint of management functionality ahead of Microsoft and VMware.

Perspective on Citrix: Hard to see near-term catalysts

What's new

- February announcement indicates company tries to break out of so far marginal share in hypervisor market
 - Gives XenServer away free of charge for unlimited production deployment, charges for support
 - **Focuses on virtualization management product “Essentials”, targeting both Hyper-V and XenServer environments** (more than triples the addressable market)
 - Extends channel as Microsoft will be reselling Essentials
 - XenServer will be embedded into XenApp – suggesting the company did not get much traction selling XenServer into the 1m XenApp server installed base
 - Incorporates more storage mgt. functionality, positions itself as an implementation of storage mgt. that allows for more differentiation by the storage vendor

What to watch for

- Desktop virtualization, whether for Citrix or VMware, is unlikely to gain traction in 2009
 - Significant up front data center capex required for infrastructure to manage desktops
 - Hard ROI in management opex **so far has been difficult to measure (labor cost savings ‘soft’)**
- Customer feedback on Citrix Essentials, so far lagging in functional parity with VMware

SWOT for MSFT

Strengths: Besides slowing market adoption to more closely match their delivery schedule, they can leverage: a) ability to bundle; b) customer familiarity with their Windows management tools; c) credibility with and channel to both infrastructure and application buyers; and d) broad ISV support.

Weaknesses: Several years behind VMware in second wave functionality for HA/DR.

Opportunities: Can leverage their considerable assets and ongoing investment in systems management independent of their virtualization effort to compete with VMware (and others) in data center automation market in 3 to 5 years.

Threats: Desktop virtualization the way VMware and Citrix are approaching it threatens to disconnect the historical tie between Windows and OEM hardware by which Microsoft gets paid for every PC that ships.

Perspective on Microsoft: **Hyper-V confusing the real opportunity**

What to watch for

- Microsoft extracts higher prices for the right to virtualize on the server and the desktop
 - Mix shift in Windows Server towards the Data Center Edition (highest priced at \$3k/processor) because of virtualization licensing limitations on Standard Edition (priced at \$1K + CALS)
 - **Server applications not covered by Software Assurance hence need “extra” licenses in case of vMotion**
 - Remote Windows desktop appears to cost \$100/user/year on top of \$70-\$110 perpetual OEM license

IV. Server Virtualization Wave 2 – Business Continuity with Implications for Backup and Recovery, High Availability, Disaster Recovery, as well as Virtualization Vendors

Key vendor takeaways

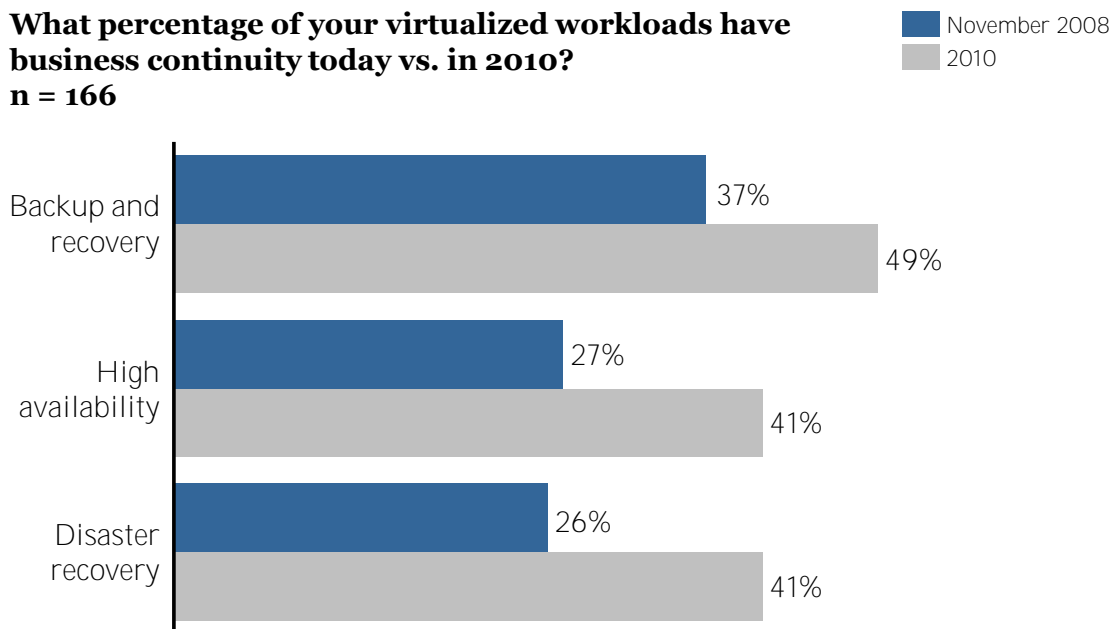
Higher penetration: A new market opportunity for virtualization is opening up that will ultimately deliver higher server virtualization penetration than consensus expectations.

Traditionally, 10-20% of servers ship with high availability (HA) and disaster recovery (DR), which are the two components of business continuity (BC) that are going through the biggest transformation. Our interviews and survey suggest virtualization could add as much as 20 points to that by 2010. The opportunity is opening first and primarily for VMware and Citrix and eventually for Microsoft with future releases of its virtualization products. This functionality not only facilitates backup and recovery, but also delivers high availability and disaster recovery at an overall cost that was previously unattainable to customers.

Survey suggests substantial increase in business continuity penetration among virtual workloads by 2010

What percentage of your virtualized workloads have business continuity today vs. in 2010?

n = 166



Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

Plans for deploying business continuity functionality based on virtualization show material growth. The penetration rate for current HA/DR deployments is somewhat higher than the traditional 10-20%. Respondents may have under-counted their infrastructure servers and focused on applications.

Slow price erosion: Mainstream customer acceptance of this functionality may not be in time for VMware to maintain its ~\$5,000 SKU (for two sockets with as much as six cores each) as its overwhelming high-volume price point.

Competitive pressure is pushing the price for more basic consolidation functionality downward faster than VMware can get customers to consume their higher value-add HA/DR features. The problem is that customers are hesitant to entrust VMware with HA/DR for additional servers running more mainstream enterprise applications, such as Exchange or SQL Server, without having a chance to test it out on infrastructure and less **critical applications. The “owners” of these new applications need time to become comfortable with a new platform.** In the meantime, VMware can upgrade its installed base of IT infrastructure servers with this functionality the same way Citrix can go after its 1 million XenApp servers.

HA/DR platform disruption: Virtualization creates a new platform for delivering HA/DR the way server operating systems such as Windows, Linux, Unix, or applications such as Oracle or Exchange deliver it today, but at a much lower TCO.

Specialist HA/DR vendor Symantec, with its cross-platform Veritas Cluster Server product (approximately \$550-650 million in revenue), is trying to stay ahead of the advancing new platform technology by addressing more complex, multi-server, multi-platform, mission-critical applications. The specialized software from Microsoft, IBM, and Oracle, while large in absolute dollars, is immaterial to their overall businesses.

BR platform faces limited disruption: Virtualization-specific BR created a temporary opening but hypervisor increasingly becomes just another platform. Symantec NetBackup remains strong in the enterprise.

The key emerging elements of value are application awareness, incremental-forever-deduplicated snapshots that can also be used for DR/HA, consistent enterprise-wide orchestration of the process, and cataloging the backups.

Application awareness used to be characterized by economies of scale as BR vendors had to build agents that knew how to “drive” each application that needed backups. On Windows today that’s no longer necessary as each application builds in the necessary knowledge of how to drive itself using a feature called VSS. Increasingly, the snapshots come from the storage vendors. And, finally, the orchestration and cataloging comes from vendors such as Symantec or CommVault. At the lower end of the market, where **Quest’s Vizioncore pioneered the virtualization-specific BR product**, we expect to see customers favor single vendor solutions expected to be offered by VMware and Microsoft.

Key controversies

With more and more applications considered business critical, does that not expand the market for vendors that deliver business continuity capabilities, such as pure-plays Symantec and CommVault in particular?

BR, HA, and DR have been growing rapidly over the past few years. However, virtualization is radically changing how they get delivered. HA and DR traditionally required extremely labor-intensive configuration and maintenance of collections of server software, server hardware, networks, and storage. Customers are able to apply newly cost-effective versions of business continuity capabilities to both previously consolidated servers, as well as newly virtualized production applications.

Symantec and CommVault are the two vendors with significant existing business continuity (BC) franchises potentially most negatively exposed to this shift. In the short term, however, both vendors are likely to continue to see surging demand in their BC businesses as more non-virtualized application workloads continue to get BC capabilities. Over the next several years, however, Symantec will have to prove its multi-operating system, multi-hypervisor platform strategy for HA over the value of native platform capabilities in Windows and VMware or specific server applications like Oracle. Our surveys indicated customers have a preference for using their platform vendors, but they may not be anticipating that multi-tier composite applications will likely span platforms and require multi-platform HA management tools as well. Symantec BR continues to do well in the enterprise because it helps customers maintain consistent processes, especially when they have a multi-vendor storage environment.

CommVault continues to leverage its early commitment to pure disk-based BR and related processes, neither of which are being completely redefined by virtualization.

Doesn't backup and recovery grow dramatically in a world of networked storage and disk-based backup and recovery?

Yes. Both technologies simplify, lower the cost, and improve the performance of backup and recovery (BR). However, customers have been pushing vendors to change their pricing model from one charging for a physical server with a single application to one charging for a server with all its virtualized applications, potentially collapsing the size of the overall market opportunity.

It appeared that Symantec and CommVault would be negatively impacted by this shift. Now, however, Symantec offers two pricing models. One offers a premium client for accessing newly consolidated servers. Symantec reaches breakeven around a ratio of 10 virtual workloads to one physical server. The other model is based on data volumes backed up, making the distinction between physical and virtual irrelevant.

From CommVault's perspective, the expanded capacity of server apps presented as much of a threat as collapsing many workloads onto a virtualized server. Microsoft Exchange 5.5 was able to support 500 mailboxes per server. One Exchange 2007 server

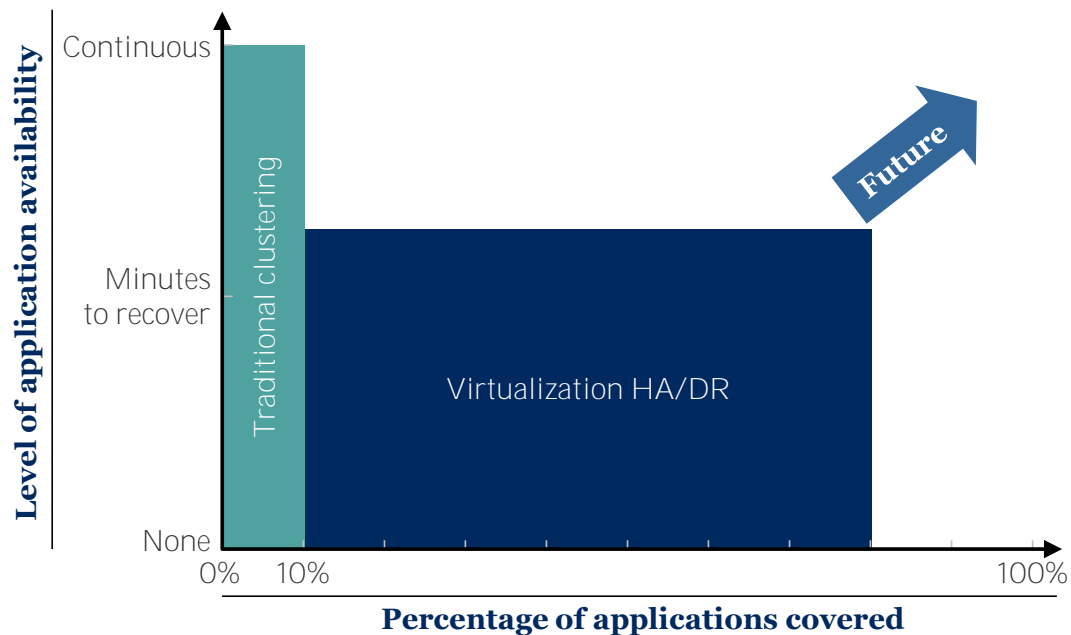
today can support 2,000+ mailboxes. The cost of a backup client license remained the same. In CommVault's case, they are now selling more than basic data protection, adding reporting, de-duplication, replication, archiving, and other functionality that is more back-end centric than just the client backup license.

Market dynamics

Market overview

HA functionality is currently deployed on only 10-20% of servers because of capex and opex cost constraints. Virtualization is enabling enterprises to evaluate eventually driving that number north of 50% because of the radically improved economics. Today, the level of HA functionality delivered by the virtualization vendors is considerably less than the specialized software from Symantec, Microsoft, and Oracle. However, the level is rising quickly, requiring the specialized vendors, Symantec in particular, to move up market.

Virtualization enables good enough high availability to reach much higher penetration

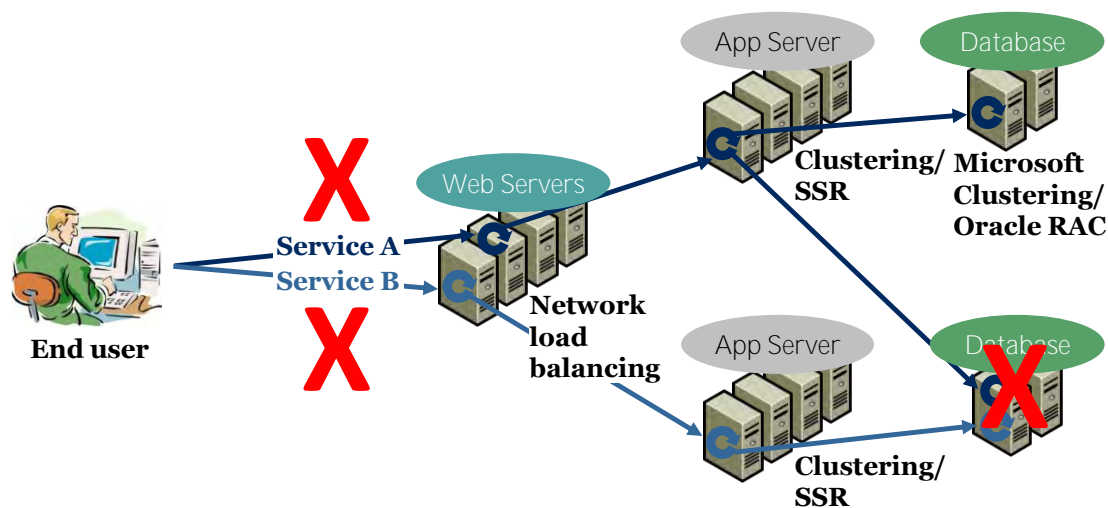


Source: VMWare

Traditional HA/DR functionality can deliver the highest availability, but its traditional cost and complexity have limited its penetration. Virtualization vendors, starting with VMware and Citrix, are making it easier to deploy basic functionality.

As virtualization penetrates increasingly higher tiers with more critical applications, more and more workloads get HA/DR.

Traditional application availability depends on many complex components, any of which could turn out to be the weakest link



- Availability only as good as weakest link
- All applications must be highly available
- Proliferation of complex availability solutions (clustering, NLB, SSR)
- Complex DR plans
- Testing for a disaster is very cumbersome

Source: VMWare

Application-specific HA/DR: Applications are getting increasingly interconnected, starting with the simplest three-tier application with Web servers, application servers, and database servers. All the relying components will need at least basic HA capability because the system is only as reliable as the weakest link. It is possible to use different HA/DR technologies at each tier, but that adds extremely burdensome complexity and makes it difficult to manage the application as an end-to-end service.

Microsoft-centric HA/DR: Enterprises that are primarily Microsoft-based typically leverage the individual HA/DR capabilities that are specific to Exchange, SQL Server, and Sharepoint. For other workloads which are not HA/DR or cluster-aware, they can leverage the application-agnostic capabilities of Hyper-V. Microsoft claims these

virtualization-based HA/DR capabilities will match VMware's current functionality sometime in H2/2009 or H1/2010.

Symantec's evolving cross-platform HA/DR: As Symantec's Veritas Cluster Server One matures across OS and virtualization platforms, it also becomes a strong candidate. Its unique value proposition is that it can manage an application end to end no matter what operating system or virtualization platform its components run on.

VMware and Citrix HA/DR: Using virtualization as the platform, customers can deliver HA/DR capabilities across multi-vendor applications and operating systems. Today, however, these capabilities are not fully application-aware. In other words, they know when the server or guest operating system goes down, but without future functionality, they don't know when the individual application components fail.

Disaster recovery has traditionally been designated only for the most mission-critical applications such as SAP. At the risk of over-simplifying, DR is very much like HA but in this case the systems failover to a different site that might be across town or even on a different continent. Its low penetration rate was dictated by the complex maintenance of a duplicate stack of every component of hardware and software at the recovery site. Like with HA, virtualization simplifies making the failover infrastructure look like the original site and orchestrating the movement of all the high priority application workloads when required. As a result, customers are now planning higher penetration rates for DR. Virtualization-based approaches generally do not offer continuous availability, but make it easy to deliver coverage to all applications on the virtualization platform.

Use cases

As more end users within an enterprise, as well as customers, rely on more services delivered online, downtime becomes less permissible. Although it is the application owners who dictate these requirements and have the budget to enable it, infrastructure teams are the ones who have to deliver it cost effectively. VMware has traditionally reached the infrastructure buyer. Citrix has also reached an infrastructure buyer, though one focused on managing desktops.

Business benefits

HA functionality from Microsoft, Oracle, and Symantec today restarts an application if the software fails. VMware and Citrix today actually just keep things running if the hardware, virtual machine, or operating system fails. Citrix partner Marathon Technologies, however, does offer application-aware HA and DR for Microsoft server applications today. But both VMware and Citrix have plans to deliver application-level HA and DR in the near future.

Growth drivers

Market size

Measuring the revenue growth of HA and DR is challenging. It has been sold as a separate SKU from vendors such as IBM, Microsoft, Oracle, and Symantec, but not **broken out in their segment reporting. We estimate that Symantec's HA/DR business**, primarily its Veritas Cluster Server, is roughly \$550-650 million out of its \$6 billion in total revenues. We believe its BR business, based on BackupExec and NetBackup, is another \$1.1-1.2 billion.

Oracle's HA/DR business is primarily in its Oracle Real Application Cluster (RAC) product, which brings in just under \$0.5 billion in revenue. Although it positions the product as both a scalability and BC product, we have heard in multiple customer and vendor interviews that it is used primarily in a traditional two-server HA configuration. Like traditional BC solutions, it takes special training and is fairly fragile in operation.

Microsoft clustering revenue for Windows, SQL Server, and Exchange are more difficult to estimate.

Dramatic drop in capex and opex requirements combined with greater elasticity of demand is driving growth, with penetration increasing from 10-20% of servers to 50% or more.

Virtualization is the latest technology to drive down the cost of delivering HA and DR capabilities. Early technologies demanded proprietary mini-computers and mainframes. The follow-on generation required relatively less expensive, specialized versions of management tools, server operating systems, and applications running on standard hardware, but with very high opex overhead because of the administrative complexity.

At the same time that cost is coming down, the elasticity of demand is increasing. Resiliency requirements that once applied only to specialized systems, such as **American's Sabre reservation system, are becoming commonplace not just for externally-facing applications, but internal ones as well.** So as the cost of HA and DR come down, demand is growing dramatically.

Share shift drivers

Emergence of new platform that unifies administration and increases automation.

As with any traditional technology shift, business continuity's shift to a virtualization-enabled platform enables new entrants to capture share. Virtualization-based approaches to BC, starting with VMware and Citrix and likely eventually to include Microsoft, are expanding the market and likely to capture much of the new growth. Symantec is positioning itself as the platform-neutral, high-end offering. It is clear from customer pilots that they expect to deploy a high volume of BC functionality on their **virtualized infrastructure. It's not yet clear whether the traditionally much smaller**

share of infrastructure that was more heavily focused on Unix and devoted to higher-end BC using Symantec's Veritas Cluster Server will see substantial growth.

Virtualization delivers three crucial technology enablers that reduce the previously high administrative complexity, which kept opex high, limiting BC applicability.

It does not require an administrator to keep the original machines and the failover machines identical across changes in firmware, operating system versions, patches, configuration, middleware versions, and applications. Instead, it wraps up all the software on the original machines as a single virtual machine file and makes sure it is up to date on the failover machines. Simultaneously, the virtualization software makes all the machines look alike for the software that sits on top and moves around.

It automates failover operations. Traditional software requires a series of manual steps that become progressively more complex based on the complexity of the original environment. That complexity could include all the applications and the dependencies between their components and all their connectivity and storage requirements. Putting all those steps together and keeping them current as pieces of the software stack evolved **required a complex "script."** That script was so complex that many, if not most, customers rarely if ever rehearsed to make sure it worked. Virtualization, by contrast, presents an automation layer that simplifies the orchestration of all these activities.

It unifies the HA and DR processes and procedures across different approaches taken by operating system, middleware, and application vendors. Traditionally, Web servers, application servers, database servers, and operating systems all had their own approaches to BC implemented in their special-purpose BC versions. When operating together as part of a multi-tier application service, it became extremely difficult to keep all the elements operating together when there was a problem. By contrast, virtualization platforms enable administrators to apply availability priorities and policies to all elements in an application service. An example of the automation brought about in this **new world is Brocade's Server Application Optimization product, which** integrates Microsoft System Center Virtual Machine Management and SAN management to reduce opex and complexity, notably so that isolation and connection priorities are maintained as workloads are moved around for BC purposes. Recently, VMware has even introduced the ability to orchestrate the failover of an entire primary site to a DR site.

SWOT for VMW

Strengths: Installed base and time to market. VMware's installed base of 1m servers can be upsold and outfitted with HA/DR functionality. The millions of workloads already consolidated on its infrastructure can help accelerate getting application owners comfortable with entrusting their applications with VMware HA/DR.

Weaknesses: Channel. VMware currently reaches an infrastructure buyer with a message of capital efficiency. It needs to reach the application owner with a message of platform and service reliability.

Opportunities: Higher penetration based on a value proposition of opex reduction and administrative simplification. HA/DR based on virtualization can change the economics of delivery.

Threats: Moderately narrow window of opportunity. Microsoft is roughly 2 years behind today's functionality.

SWOT for CTXS

Strengths: Installed base of XenApp/Presentation Server. Citrix has 1 million servers running Presentation Services, a precursor of desktop virtualization that is yet to come. Citrix is the natural source of HA functionality as customers consolidate XenApp on XenServer.

Weaknesses: Credibility and channel to reach beyond the desktop infrastructure buyer.

Opportunities: Channel and credibility in the mid-market. Citrix's presence with the enterprise applications buyer may not be strong, but it is more likely the role of the desktop infrastructure buyer may be closer to the application buyer in the mid-market. Their large channel presence should help them reach these buyers.

Threats: Microsoft. Like with VMware, basic HA/DR functionality from Microsoft is not too far behind.

SWOT for MSFT

Strengths: Ability to bundle. As both a server operating system and application developer, Microsoft can build HA/DR functionality into its high-volume products. As a result, there is less need for separate products to provide similar functionality. For example, since Windows clustering became mature over the last few years, other ecosystem partners such as storage system vendors have limited their testing of Symantec's Veritas Cluster Server on Windows.

Weakness: High customer opex. Its current products use traditional HA/DR technology, based on clustered servers and data replication, that requires relatively high customer opex.

Opportunities: Ability to build on virtualization. As its virtualization feature set matures, it should be able to offer more automated HA/DR that also works consistently across its own and other products.

Threats: Late to market. The downside scenario is that other vendors will be able to fill the gap Microsoft has created. Microsoft appears a couple years behind others in offering end-to-end application system management across physical and multi-vendor virtual platforms.

SWOT for SYMC

Legacy HA solutions add value to VMWare HA today, though differentiation may diminish over time

Example: Symantec Veritas Cluster Server

Cause of failure	VMWare HA	Veritas Cluster Server
App processes crash/hang		✓
App process startup order		✓
Admin accidentally caused failure		✓
Configuration changes		✓
OS failure	✓	✓
NIC or network failure		✓
Storage connectivity failure		✓
Virtual Server failure	✓	✓
Physical Server failure	✓	✓
Data center failure	✓	✓

Source: Symantec

Strengths: Platform-agnostic lead in functionality. Symantec has technology that will ultimately allow it to manage HA/DR for all the components in an application service, from the Web front end to the application servers to the database. These components can span physical servers, as well as virtual servers from VMware, Citrix, and Microsoft. Symantec also has a direct sales force, seasoned with years of experience, selling HA/DR solutions that must appeal both to infrastructure buyers and application owners. This \$550 million to \$650 million business has a scale that is almost half as big as all of VMware and a little further behind the whole of Citrix.

Weaknesses: Less relevant historic platform presence. Symantec’s HA/DR heritage has primarily been on Unix platforms and in multi-platform shops. With 80% of servers now shipping with Windows, they have less room to add value on top of Microsoft’s Windows-only solutions. In VMware shops, they have a similar challenge.

Opportunities: Market window. There is a window of multiple years before the emergence of end-to-end data center systems management platforms. A vendor who can deliver HA/DR for customers with physical and multi-platform virtual systems should be able to carve out a profitable position.

Threats: Comprehensive management systems. In shops that are a mix of physical systems and multiple virtualization platforms of the future, HA/DR functionality is likely to be sourced from Microsoft or one of the Big 4 systems management companies. HA/DR functionality is likely to be a property of an end-to-end data center systems management platform. What is not yet clear is whether that day is 3 years off or 7 years off.

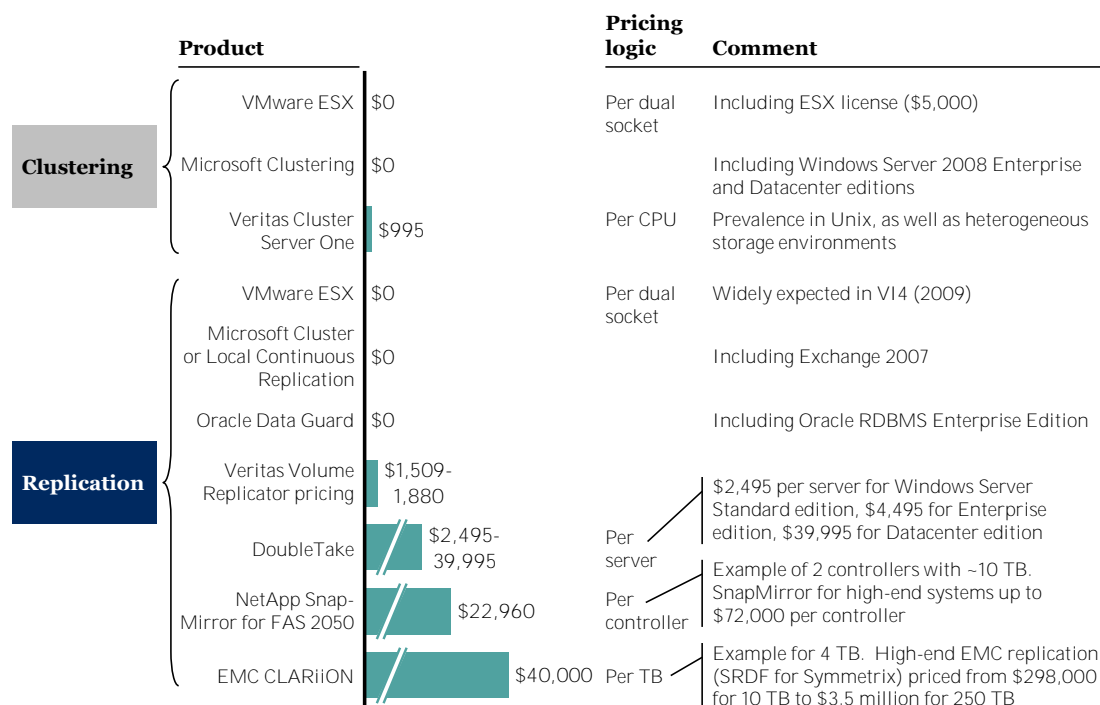
Economics

Impact of emerging business models

The business model for delivering HA/DR value is now undergoing a significant transition from the last generation, when it was delivered as a premium SKU for mainstream applications such as Oracle. For Symantec, it has been a specialized product itself. However, the virtualization and, eventually, the systems management **vendors will try to deliver HA/DR as one attribute of an “Intel Inside” offering** that guarantees the end-to-end delivery of a multi-tier application. In other words, it is likely to be priced as a premium feature of a broader offering.

Virtualization will impact the economics of high availability

ILLUSTRATIVE – NOT MEANT TO SUGGEST FUNCTIONAL PARITY



Source: TechAlpha analysis

Impact of emerging technical and architectural changes

What originally required tightly integrated custom hardware/software hosts from IBM, Tandem, or Stratus next evolved into special-purpose software from IBM, Oracle, Microsoft, and Symantec. This new type of HA, however, involves administrative or operational costs that are many times the cost of the server hardware and software. DR is even more complex because it has to work across sites and requires the complex orchestration of a long sequence of activities to bring all relevant systems back online. The special-purpose software from mainstream vendors requires only commodity hardware. However, it typically requires duplicate systems be available on standby and has extremely highly complex administration requirements. In other words, while the hardware costs have ridden the commodity cost curve, the ongoing opex costs are high.

V. Server Virtualization Wave 3 – Data Center Automation with Implications for Systems Management as well as Virtualization Vendors

Key vendor takeaways

The Total Addressable Market for data center automation is likely larger than consensus growth estimates applied to today's systems management market.

VMware and Microsoft have sold the automated, “lights out” data center as one of the largest opportunities in enterprise software. CA, BMC, HP, and IBM are today's systems management incumbents and have also been selling an advanced vision as well.

We believe there is a greater-than-expected demand in this area as software increasingly substitutes for costly data center operations labor. Today roughly 50% of IT budgets are for labor according to IDC. The ultimate objective for data center automation is to enable enterprises to build private clouds that manage and distribute online services while ultimately bringing the required labor component down radically.

Perspective on systems management: Cloud management software may present large opportunity

- **Systems management before virtualization was an oligopoly** (HP, IBM, CA, BMC plus specialized vendors) due to high cost of wrapping mgt. tools around each application, intensive field customization/services required for each customer environment, and lack of economic incentives for vendors to cooperate.
- **Private clouds will have three software layers**, each with its own economic model:
 - **“Device Drivers”** make compute, storage, and network infrastructure look like a single machine. Product leadership is determined by the scope of devices the software can homogenize. VMware has a big lead over Citrix and Microsoft.
 - **“Management Tools”** automate the provisioning, configuration, monitoring, etc. The big 4 - CA, BMC, IBM, HP – enjoy a big head start from work on non-virtualized infrastructure.
 - **“Application Services”** orchestrate all the software components into a private cloud that can deliver secure, scalable and resilient online services. Likely to remain only a partially achievable goal. No substitute for current one-off customer- and application-specific integration.
- **Vendor implications**
 - **HP, IBM, CA, BMC:** Market likely to show strong growth but with no real change in margins or industry structure.
 - **VMware:** Does not have significantly privileged position in “management tools” or “application services” since other vendors will have access to critical information in “device driver” layer; will offer basic capabilities for management and applications.
 - **Microsoft:** if anyone has a chance to own all 3 layers, it would be Microsoft in SMB customers where their ubiquitous deployments with Windows Server, .NET, and server applications (SQL, Exchange, SharePoint) would give them privileged visibility to keeping the stack in an end-to-end environment healthy.

Source: TechAlpha analysis

Key controversies

Isn't VMware well positioned to lead in this market?

VMware's ultimate growth path into this market is likely to experience greater than expected competitive intensity, primarily from Microsoft.

There are two key success factors in this market. The first one is the ability to make a sprawling and heterogeneous collection of servers, storage, and networking look like a single machine and carve it up into isolated portions for different application services. This capability dramatically changes the economics of administering data centers and managing software that can be delivered as an online service. VMware and Microsoft are likely to share the leading claim to this first success factor.

The second factor to leverage for success in this market is the ability to combine infrastructure and applications management. That is the critical requirement for turning an IT operation into a private cloud that can deliver rock solid online services. While VMware has some leading-edge technology to wrap around applications, as long as commercial and corporate developers primarily target Windows as their application platform, they will likely be at a disadvantage to Microsoft.

Microsoft can leverage three advantages.

First, since Windows accounts for roughly 80% of X86 server unit shipments, software developers of just about any stripe have to do at least some work to wrap Microsoft management tools around their applications.

Second, because Microsoft is one of the leading server application vendors itself, it can throw its weight behind its own management standards. For example, it created a new way to do application-aware backups in Windows without requiring every backup vendor to write an agent for every application. If Microsoft had any trouble establishing this Volume Shadow Copy service, or VSS, its use by SQL Server, Exchange, and Sharepoint would have eliminated any doubt.

Finally, because Microsoft is a leading provider of development tools on Windows with its .NET platform, it will be able to capture even more management information about the subset of applications built on their tools.

VMware's best potential for upside in this market is twofold.

First, the extent to which commercial or corporate software developers use development platforms that are independent of Windows likely means neither company has an advantage in collecting management information. Examples of these fast-growing platforms include J2EE, PHP, and Ruby On Rails. Some of these platforms do not require any conventional operating system.

Second, if VMware can proliferate its platform ubiquitously, virtualizing practically all servers within an organization on its technology, it may have more of an advantage in

managing the infrastructure it sits on and the applications that sit on it. This scenario is supported by survey data showing that i) 51% of enterprise respondents plan to have only one hypervisor in use by 2010, ii) respondents – including those who plan on using two or three hypervisors – estimate that the dominant hypervisor in their environment will take 86% share, in other words, they will rely mostly on one vendor, and iii) VMWare is believed to be that vendor by 66% of enterprise respondents

Market dynamics

Market overview

Summary

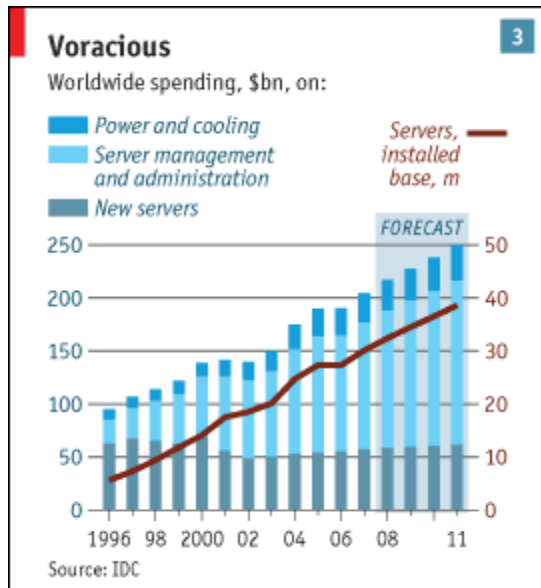
Today's systems management tools from CA, HP, and IBM have their heritage primarily in managing infrastructure, not applications. Microsoft and BMC currently have more application-centric assets. Oracle and SAP also have systems management tools, but they are purpose-built to manage their own applications. Citrix appears to be the **vendor most intent on aligning itself with Microsoft's Dynamic IT vision and filling in the holes** as that rolls out.

User Scenarios

The vision is to automate and orchestrate the delivery of services from virtual pools of infrastructure to deliver business application services according to policies set in SLAs. This requires capabilities such as dynamically provisioning servers and applications based on business needs, ensuring ongoing configuration compliance, and managing application performance once apps are in production.

Business Benefits

Today, the proliferation of x86 servers, as well as VMs, has created management chaos. It has left some administrators wishing the days of the mainframe would return. As an industry, we have collectively traded the centralized administration of the mainframe for the better price performance and greater departmental control over resources of distributed systems with its attendant explosion of administrative expense (see IDC figure cited in The Economist below). VMware, Microsoft, Citrix, BMC, CA, HP, and IBM want to deliver the best of both worlds.



Growth drivers

The Data Center Automation Wave represents a Holy Grail bigger than server consolidation and business continuity combined.

Traditionally, administrators managed resources such as servers, storage, networks, and applications as discrete assets. In a world where applications can consume other services as well as infrastructure to deliver rich online services on demand, a new management infrastructure is required. The stories of Microsoft and Google building data centers with 10,000s or even 100,000s of servers managed by only a handful of **administrators are extreme examples of what's to come.**

Share shift drivers

The rise of virtualization does not necessarily mean the traditional systems management vendors get knocked out of the ring.

Traditionally, specialized, dedicated sets of administrators managed separate sets of resources such as servers, storage, networks, and applications. Virtualization does change how management tools and applications see the data center infrastructure, creating the illusion of a homogeneous pool. But **virtualization doesn't appear to render all existing management tools incompatible with the new architecture, the way the shift from mainframes did. In other words, virtualization doesn't appear to be enough of a discontinuity to automatically anoint VMware, Microsoft, and Citrix the new leaders solely by virtue of their new platforms.** Thus, virtualization platforms from VMware, Citrix, and Microsoft are likely to exhibit more of the properties of a new operating system than a fundamental shift such as the one from mainframes to distributed systems.

Economics

Impact of emerging technical and architectural changes

The key question is whether vendors' virtualization platforms will evolve to have their own proprietary infrastructure and application management APIs. While this data center virtualization layer represents the emergence of a new operating system platform, significant differences currently exist.

Like traditional operating systems, it masks the complex and distinct elements of the underlying hardware infrastructure with its own software. Also, like traditional operating systems, it provides services to applications that enhance their capabilities, such as availability – discussed in the business continuity chapter above, scalability, security, and manageability. Most significantly, it provides these capabilities to an application service that is actually made up of many other application services or tiers. At the simplest level, it would ensure that the Web, application, and database tiers all operate in synch to deliver the desired service levels.

Unlike traditional operating systems, however, the data center automation layer currently takes existing, unmodified applications and provides them with all these additional services. Today, it appears those supporting services will be an outgrowth of **the virtual “appliances” that** are emerging to serve as deployment containers for collections of virtual machines deployed as a single online application.

In other words, the strong networking effects coming from greater ISV support and higher unit shipments do not currently appear to exist between applications and the data center automation layer. That may change in the future if Microsoft achieves a critical mass of systems management market share and can tilt the playing field in a more proprietary direction away from the management information contained in the standards-based virtual appliances.

Impact of emerging business model changes

This wave potentially represents the biggest value creation layer thus far. However, it is not likely to yield for anyone the monopoly control and rents Microsoft achieved with Windows. The emerging layer appears to deliver to the vendor control over management of the underlying hardware infrastructure – servers, storage, and networking – while reducing switching costs for customers. However, it is not clear the new layer delivers the same vendor control by establishing high customer switching costs for applications on that platform.

Both Microsoft and VMware have great ambitions for their emerging systems management businesses. **It is considered one of the pillars of growth for Microsoft's** enterprise software business. For VMware, this is the culmination of their virtual **datacenter OS vision. It's hard to quantify their expectations except that** unit pricing is likely to be at the high-end of their range, which in VMware's case is \$5,750 per dual socket server today. Citrix appears to be approaching this business more

opportunistically. It realizes it doesn't have the development resources or channel to compete head-on. Instead, it can fill openings in Microsoft's offerings the way it does with its Presentation Server relative to Microsoft Terminal Services.

Given that network effects at the application layer are not a certainty, there are several scenarios:

Best of Breed: A handful of interoperable but multi-vendor management tools that are sold to different constituents, representing best of breed tools (e.g. BMC CMDB plus Bladelogic, CA identity management, HP Opaware, Quest performance management, Symantec high availability and backup & recovery, Citrix desktop virtualization).

The big 4 dominate: HP, CA, BMC, or IBM continue to be the Manager of Managers in any given customer, with Microsoft and VMware managing their own platforms and plugging into the broader top-down solutions.

Microsoft embraces and extends: tries to battle VMware, Citrix, and the rest of the management vendors by introducing proprietary extensions to the appliance or application service management standards. It leverages its market share for Windows Server, server applications, and developer tools to enable compatible services to run with a greater level of control over their guaranteed service levels.

Ultimately, the best measure of the outcome for the data center automation wave will be **customers'** level of expense on IT. Financial services companies can spend as much as 10% of revenue today while large manufacturers might spend 3%. When operations become mature enough to benchmark one company against its peers over time and find meaningful differences, the industry will be able to determine the most effective management model.

The same goes for SaaS companies, where Salesforce.com spends 12% of revenue on IT operations, including support. Commercial management tools of the future should eventually be able to bring that number down materially for companies with newer architectures.

VI. Implications for Storage Vendors

Key vendor takeaways

The storage industry may be at the cusp of the biggest adverse structural change since networked storage began to replace direct-attached storage a decade ago.

Three developments will radically redefine the profit pools in the industry, leading to slimmer margins for all but the most innovative, software-driven players. The current recession will accelerate these three, longer-term trends:

First, server virtualization contributes to masking much of the differentiation between all but the most innovative storage vendors, transferring pricing power to buyers. This is a specific instance of the broader trend of applications (e.g., by Microsoft and Oracle) embedding more functionality to manage their underlying storage.

Second, modular hardware is emerging at all but the highest end in the form of commodity disks, augmented by flash memory for performance, and controllers increasingly built on commodity x86 servers. This will make it easier for customers to benchmark hardware costs on a per GB basis. Early evidence of this trend can be seen in the erosion of hardware gross margins that has set in at some storage vendors over the last 18 months. In response, storage vendor business models will be cracked open. What is a systems sale today becomes a separate selling motion for the software and the hardware. This will force vendors to sell software based on business value rather than systems based on capacity, a difficult transition for any company even in good times. In addition, the traditional ways vendors drove differentiation in their firmware and software are increasingly being hidden beneath management tools from VMware, Microsoft, and the Big 4 (IBM, HP, CA, BMC).

Finally, some high-growth customers, particularly online service providers, are building their own clouds. That accelerates commoditization due to the tremendous storage purchasing volume these operators aggregate as well as their tendency to rely on in-house storage management tools.

In the short term though, some noise from other virtualization-related trends risks obscuring what's really happening from those who are not focused on these more important adverse secular trends.

Trends that are positive for near-term demand include:

Virtualization is greatly accelerating the near-term, top-line growth of storage vendors. Storage typically accounts for more than a third of the total capex on VMware server consolidation projects. Our survey indicates that more than half of the networked storage budget for 2009 and 2010 is specifically to support virtualized workloads.

Part of that growth is driven by new workloads being virtualized, notably tier 2 and tier 3 applications such as e-commerce, CRM, ERP, Exchange and SQL Server, which goes

much beyond where virtualization recently made headway, such as IT infrastructure, directory, file and print, test and development workloads. For instance, Microsoft **Sharepoint is this generation's file server** and it is itself composed of several other server applications including Web, application, and database servers. Because information-rich Sharepoint sites **typically aren't as business critical as line-of-business** or enterprise applications, they are among the earlier candidates for the next wave of virtualization while simultaneously pushing up demand for networked storage.

More cost-effective block-based storage is enabling smaller organizations, departments, and branch offices to deploy virtualization configured for business continuity. iSCSI solutions **from HP's LeftHand Networks and Dell's Equallogic are accessible to organizations that previously didn't** have the capex or opex resources to acquire and manage a traditional SAN.

Trends that are negative for near-term demand include:

Storage efficiency technologies such as thin provisioning, de-duplication, and incremental snapshots, will have a material impact on utilization. This impact is likely to bend the growth rate in capacity demand downward both temporarily, during the time the technology is being deployed to the installed base, as well as permanently.

On average, enterprise respondents have been able to save an equivalent one-fifth to one-third of their budgets for networked storage systems and software because of increased utilization of their storage capacity. NetApp, however, goes even further and financially guarantees its customers they will save 50% of their storage capacity. **It's worth noting however, that these savings typically don't reach the full extent of customers' installed base** immediately. New technology takes time to roll out across the entire installed base.

Longer term, winners among the storage vendors will be those who drive software innovation, but also manage the difficult solution-selling transition and partner with the virtualization vendors in a way that highlights their differentiation.

In the short to medium term, winners are those best positioned for iSCSI, which is well-suited to host the tier 2 and tier 3 workloads increasingly being virtualized over the next **couple years, including Exchange, SQL Server, Sharepoint, and IBM's Lotus Notes.** It is a less expensive and easier to manage, though currently lower performance substitute, for Fiber Channel SANs. Vendors most favorably exposed to iSCSI are EMC, NetApp, HP (through their purchase of LeftHand Networks), and Dell (through their purchase of EqualLogic).

Overall, from a profit pool perspective, we believe that the storage industry as a whole will suffer from the combination of more challenging differentiation, better utilization, and the increasing use of commodity technology, of which iSCSI is but one example.

VMware and EMC likely have conflicting interests

Finally, the inherent conflict between EMC and VMware is likely to become visible over the next year. EMC does not want VMware to accelerate storage commoditization through its software or through potential acquisitions, such as the missed opportunity to buy LeftHand Networks, which HP picked up recently. However, **EMC's** best hope for moving up the value chain away from commodity storage in the enterprise is to hang onto VMware. **EMC's own enterprise systems management software, Smarts, does not** have the traction to compete with Microsoft and the big 4, let alone VMware.

On the more distant horizon, EMC does appear to have some interesting, recently introduced software for managing rich media in public clouds. And it is hinting at interesting developments for managing personal information that may augment VMware's desktop virtualization vision.

Perspective on storage: **Storage going the way of the server?**

- **Demand stimulus:** Virtualization drives networked storage and adds 10 points annually to secular data growth. 50% of storage capex is directly driven by virtualization, double the latest IDC forecast.
- **Hardware commoditization and modularization** set the stage for vendor-independent software
 - **Flash memory** may relegate expensive FC disks to a very narrow set of use cases, drastically expanding the use of SATA disks which cost only half as much
 - **Unified computing** shifts the balance of power to server vendors, through the use of flash memory in server blades as well as rapid data center build-out via containers (the latter still a bit of a corner case)
- **Storage efficiency technologies** such as thin provisioning, de-duplication may halve the amount of incremental PB needed to accommodate ongoing data growth, lifting utilization from 37% to ~70%
- **Server virtualization** lowers differentiation and potentially switching costs among storage vendors, transferring pricing power to buyers and organizational power to the server group.
- **New storage architectures** are needed for virtualized environments (e.g., scale-out, better VMFS)
- **Unified converged networking** will bring the lower cost and complexity of the Ethernet to storage, potentially affecting 90% of all ports/workloads
- **Cloud computing build-out** will drive margin pressure
- **Vendor implications:**
 - **Less affected:** Server vendors, notably HP and DELL
 - **More affected:** Storage pure-plays; HBA vendors

Source: TechAlpha analysis

Key controversies

Isn't storage riding an extremely strong set of secular growth drivers driven by the shift away from direct attached storage (DAS), greater duplication of data for business continuity, and accelerating use of disk-based snapshots for backup and recovery?

All these growth drivers are indeed in place and driving a growth in demand for raw data storage capacity.

However, as we will explain further in this chapter, increasing storage efficiency in the form of thin provisioning, data de-duplication, and incremental snapshots produces an offsetting effect which may slow unit growth in the short term and permanently reduce unit growth in the medium to long term.

Growth in revenue terms is lower still due to declining differentiation (see Key Vendor Takeaways above) as well as ongoing unit price declines. Historically, while data volume growth has been around 50% per year, price per GB has decreased by 26-33% per year. Combined with the effect of mix shifts (e.g., favoring lower cost technology) which contributed another negative 10-15% per year, this has led overall industry revenue growth in the 7-9% range. **Our exhibit 'Storage Demand Growth with Virtualization' below elaborates** on this.

As we explain in this chapter, virtualization creates a short-term boost to demand, but that is or will shortly be dampened by a number of negative trends. Different vendors bring very different assets to this game; hence it is more meaningful to examine which vendors stand to gain versus lose.

Market dynamics

Market overview

Virtualization drives demand for networked storage.

Server virtualization is overwhelmingly **tied to the server hardware refresh** cycle, which in turn overwhelmingly tends to require networked storage in place of the historically more prevalent direct attached storage.

Only **networked storage enables application mobility**. This is critical for enabling planned downtime as well as high availability, including load balancing. It's also helpful for migrating data to different storage tiers as the business value of a particular data set changes.

Virtualization also **facilitates backup and disaster recovery**, which in turn drive storage capacity growth. Adding disaster recovery to a workload for instance doubles the storage capacity required (i.e., 1x at the primary site, 1x at the secondary site).

Moreover, Tiers 2 and 3 contain the **more data-intensive next wave of applications to be virtualized**, such as Exchange, SQL Server or Web infrastructure. This compares to less data-intensive Tier 4 IT infrastructure workloads such as file and print servers, Active Directory or DNS servers that are already virtualized.

User Scenarios

When customers first get started with virtualization, they tend to use incumbent networked storage technologies (notably FC SAN or NAS) because they share existing storage resources across virtualized and non-virtualized environments. Hence, they will use incumbent vendors like IBM, HP, EMC for FC SAN and NetApp or EMC for NAS. This leads to a sub-optimal allocation of the IT budget though, since a division within an enterprise tends to put their virtualized workloads on a FC SAN even if in a green-field situation the workloads would not justify the cost and complexity of a FC SAN. In an

increasing number of cases, though, customers will choose the vendor and technology best suited to just these virtualized workloads¹. This should benefit the iSCSI vendors in particular (EqualLogic/DELL, LeftHand Networks/HP, NetApp).

Business Benefits

Server virtualization enables customers to “do more with less” with storage.

Control costs with better storage utilization (e.g., via automated storage thin-provisioning, incremental snapshots, de-duplication). In combination with the rapid server provisioning offered by the server virtualization products this helps enable a **capacity on-demand model**.

Improve availability via efficient replication (e.g., low-overhead or incremental snapshots from the storage system, without consuming CPU cycles or server I/O bandwidth), rapid cloning, and fast recovery. In combination with the application mobility enabled by the server virtualization vendors, this enables **fast and cost-effective disaster recovery** without costly dedicated standby servers.

Improve manageability. Storage solutions are becoming increasingly integrated with the server virtualization software management layer. This enables the server administrator to manage the entire infrastructure through a common interface that can leverage the underlying capabilities of the storage systems, potentially without storage administrator involvement. Storage administrators can simply set policies which govern

¹ The rationale for this lies in the two alternative ways in which a virtual machine (VM) treats user data. Today, in more than 90% of virtualization environments, user data is kept within the VM. This is called the stateful mode. In this model, one storage connectivity option (FC SAN or iSCSI or NAS) has to be used across all workloads being virtualized. VMware would prefer this model because it provides their tools with more management control, obviating the need for some application specific manageability tools. Increasingly though, customers keep their user data separate from the VM. This is called the stateless mode. TechAlpha expects this mode to prevail in 20-30% of deployments over the next 1-2 years. In stateless mode, the operating system and application binary within a VM will still be served by a single connectivity option. Crucially though, stateless mode gives customers a choice over the connectivity options for the application data. We expect that connectivity to better reflect the choices customers make today, e.g., using FC SAN or iSCSI for Microsoft Exchange since Exchange does not support NAS.

what server administrators can do. **Automation** reduces the labor required for tasks such as storage moves, adds, and changes for the ever-expanding pool of virtual servers.

Growth drivers

There are several positive and negative drivers of capacity growth:

Virtualization calls for networked storage, which may yield a temporary spike in higher-than-consensus growth in storage capacity, in particular since the next wave of applications to be virtualized are more data-intensive than the IT infrastructure and non-production workloads of the past.

To quantify the relationship between virtualization and storage: storage accounts for the single biggest share of virtualization project capex. Our surveys and interviews indicate more than half of storage capex is directly driven by virtualization, which is double the impact forecast by IDC.

However, the growth stimulus from virtualization is more than offset by higher storage efficiency driven by increasing adoption of technologies such as thin-provisioning, de-duplication, incremental-only snapshots, and policy-based tiering of data.

Moreover, applications will increasingly embed storage management functionality, further reinforcing hardware commoditization but also reducing the need for dedicated storage management products. **An example of this is Oracle's Automatic Storage Management**, a feature in Oracle Database 10g/11g that provides the database administrator with a simple storage management interface, notably vertically integrated file system and volume manager, that is consistent across all server and storage platforms.

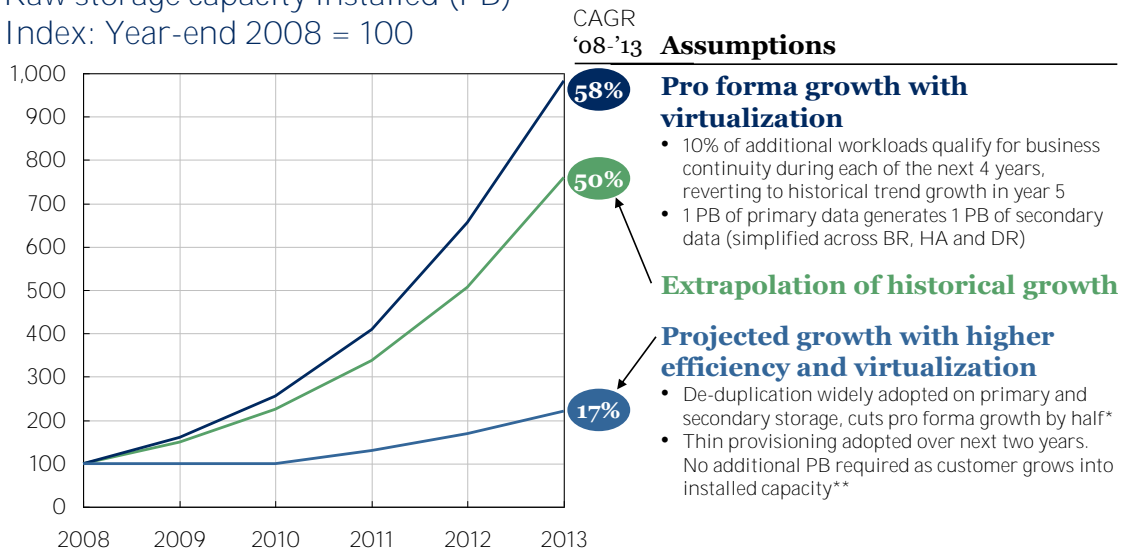
Our own analysis – see exhibit below – shows that virtualization adds almost 10 points annually for the next few years to the historical 50% annual growth rate in data quantity stored. Significantly, though, if a customer adopts de-duplication on their primary and secondary storage, that permanently halves the underlying growth rate. Furthermore, if the customer rolls out thin provisioning, in conjunction with de-duplication, no additional storage capacity might be needed during a 2-year period as that customer grows into their additional capacity.

Storage demand growth after virtualization

REPRESENTATIVE EXAMPLE

Raw storage capacity installed (PB)

Index: Year-end 2008 = 100



* Assumes the 65% of data residing on primary storage benefits from 30% savings, while the remaining 35% of data on secondary storage benefits from 90% savings, for an overall compression rate of 51%. Actual compression ratios range from 90% for backup to 70% for VMWareVMs, 55% for databases and geo-seismic data, 35% for home directories, 30% for email PST files and mixed enterprise data, to 25% for archival

** With average current storage utilization of 40-50%, it would take 2 years for a customer to grow into the 70-85% utilization that is possible with thin-provisioning, assuming a 30% post-de-duplication annual growth rate

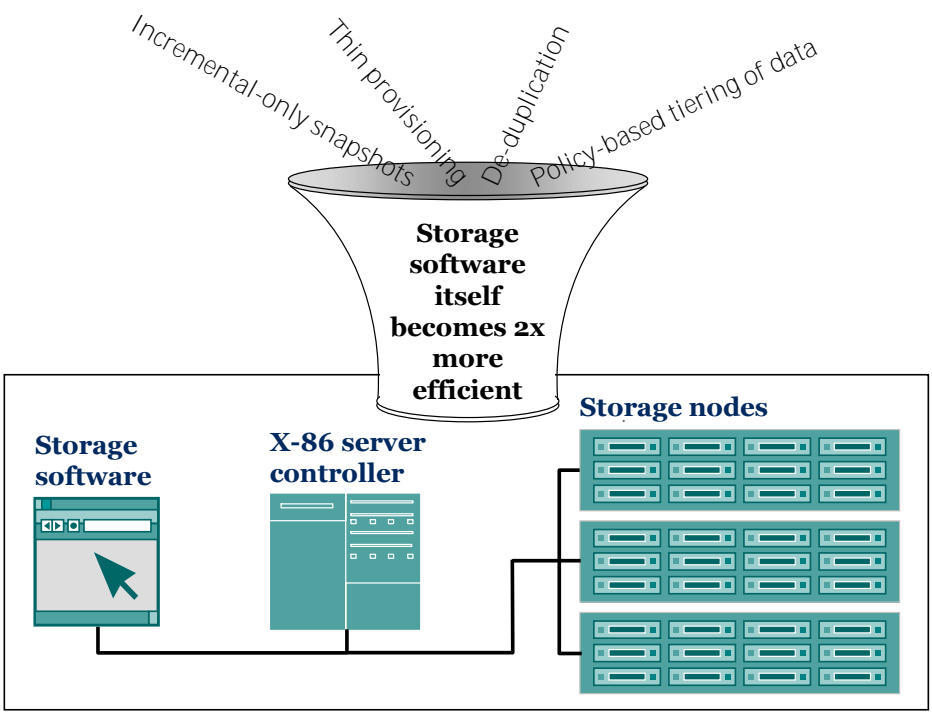
Note: Only some vendors offer de-duplication on both primary and secondary today. Actual growth depends on vendor-specific implementation of these features (e.g., efficiency of snapshots for business continuity)

Source: TechAlpha analysis

While this analysis illustrates what is possible, real-world adoption might be somewhat slower for a variety of reasons. Most important of these might be the fact that not all legacy vendors have leading-edge implementations of these new technologies, notably de-duplication on primary storage, so it might take a bit longer for these advances to reach ubiquitous penetration across all divisions of a company.

It should be noted that our what-if scenarios are more bearish than IDC. We suspect that IDC might expect new applications and use cases for data collection to prop up growth rates. IDC shows that storage volume shipments for virtualized environments have more than doubled annually in petabyte (PB) terms over the past few years. IDC does predict a slowdown in growth to 84% in 2009 declining to 73% in 2012, presumably enabled by utilization-enhancing technologies such as thin provisioning and de-duplication.

Storage virtualization drives better capacity utilization



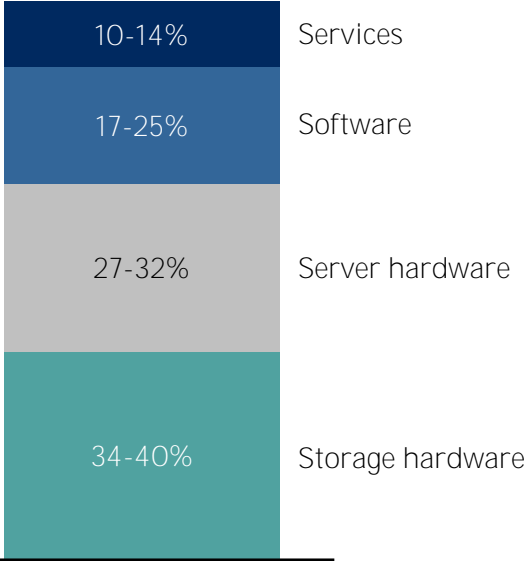
Server virtualization drives higher than consensus growth in storage capacity.

When customers first get started with virtualization, they tend to use incumbent networked storage technologies (notably FC SAN or NAS) because they share existing storage resources across virtualized and non-virtualized environments. For new server consolidation projects though, storage typically accounts for 34-40% of project capex.

Storage accounts for the single biggest share of virtualization project capex

Typical VMWare server consolidation project

100% = \$44,000-62,000



Source: TechAlpha analysis based on VMWorld interviews

Storage accounts for the single biggest share of virtualization project capex – assumptions

Typical VMware server consolidation project

Solution component	Use case	List price Dollars
Virtualization Platform(s) Servers <ul style="list-style-type: none"> Common specs: 2x quad core processors, 16GB memory Sample models: Dell PowerEdge R805, HP Proliant DL360 	<ul style="list-style-type: none"> Physical server to run virtual machines and applications 	6,000-10,000
Virtual Center Management Server <ul style="list-style-type: none"> Common specs: 2x quad core processors, 16GB memory Sample models: Dell PowerEdge R805, HP Proliant DL360 	<ul style="list-style-type: none"> Physical server to manage resources pooled by virtualization (optional) 	6,000-10,000
iSCSI SAN or NAS Storage <ul style="list-style-type: none"> Common specs: Dual controller, 4TB Sample models: Dell EqualLogic PS5000E Array, EMC CLARiiON CX3-10C, NetApp FAS2020 	<ul style="list-style-type: none"> Fabric-attached virtualized storage 	15,000- 25,000
VMware VI3 Enterprise Software	<ul style="list-style-type: none"> Virtual server software 	5,750 per server*
VMware Virtual Center Software	<ul style="list-style-type: none"> Management software (optional) 	4,995 per server**
Installation and configuration of... <ul style="list-style-type: none"> Virtual platform and management center NAS or iSCSI SAN storage array including data migration 	<ul style="list-style-type: none"> Professional services usually provided by partners 	6,000

Total 44,000-62,000

* VI pricing is for dual socket x 6 cores per socket

** Virtual Center is generally considered a necessity once 4-5 servers run VI3. VMware channel partners indicate good traction for \$15k promotion of Virtual Center plus 3 VI3 server licenses plus 30 training credits

Source: TechAlpha analysis based on channel partner interviews

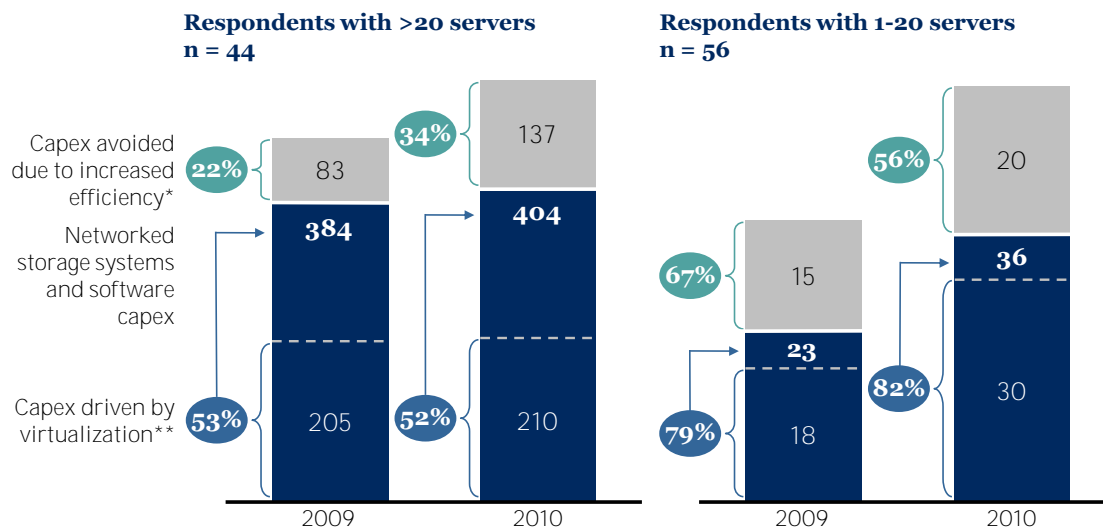
Our survey indicates that more than half of the networked storage budget for 2009 and 2010 is specifically driven by a need to support virtualized workloads.

More than half of storage capex is directly driven by virtualization

Networked storage systems and software capex

Mean capex – US \$Thousands

■ \$ in budget
■ \$ not required



* What US\$ amount would you estimate for storage spend AVOIDED because you are able to increase utilization on your existing storage capacity due to thin provisioning, incremental-only snapshots, de-duplication or because you are moving workloads to the cloud?

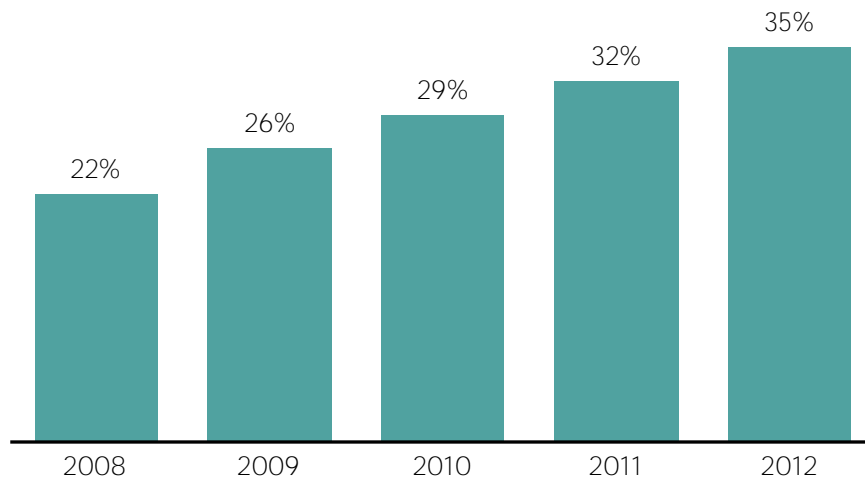
** How much of that storage budget (again in US\$ terms) is necessary specifically to support virtualized workloads?

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

This is a key area of non-consensus, since IDC top-down estimates put the impact of virtualization at less than half that.

Bottom-up survey perspective on storage spend driven by virtualization is 2x the top-down IDC forecast

IDC estimate of storage spend driven by virtualization*



* Share of external networked storage industry revenue driven by server virtualization. Excludes systems under \$15,000. 100% = \$16.8 billion in 2008 growing at 9% CAGR to \$23.5 billion in 2012

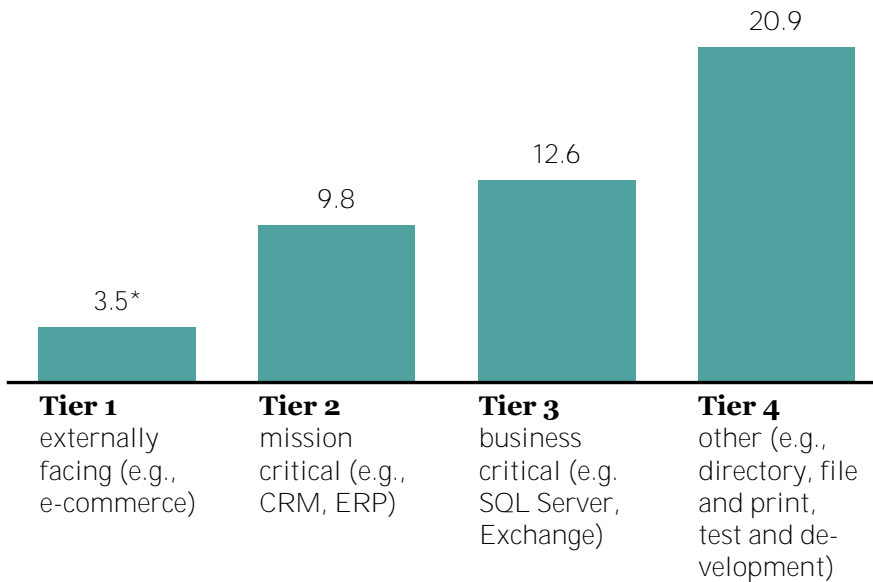
Source: TechAlpha analysis based on IDC data

The next wave of applications to be virtualized is more data-intensive than the IT infrastructure and non-production workloads of the past.

This directly contributes to storage over-provisioning: not only do these more business-critical applications generate more data, but customers are also more likely to over-provision storage. As we have shown previously – the two exhibits are repeated below for convenience – customers run fewer of the more critical applications on each **virtualized server in order to optimize for performance. While this reflects the ‘just in case’ mindset of a pre-virtual world**, a direct consequence is that more storage is reserved (and hence not available to other workloads) than is likely to be consumed.

Compression ratios decrease with application criticality

How many workloads will you be running in 2009 per virtualized server?



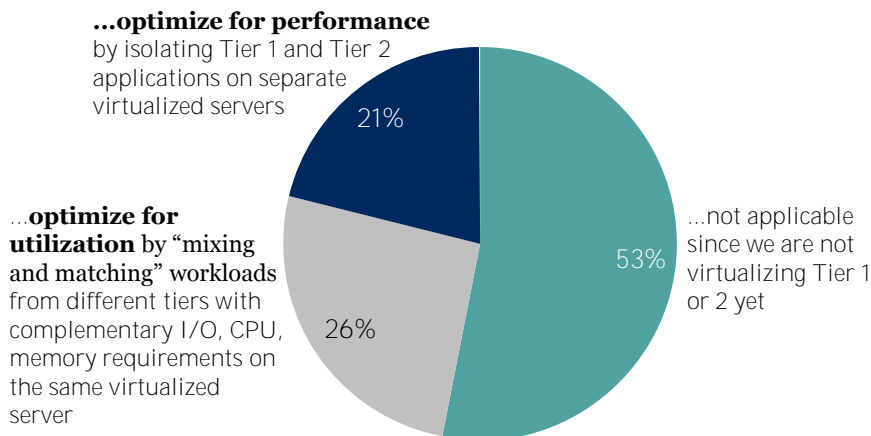
* Survey data complemented by interviews

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

Respondents seem cautious about the impact of virtualization on Tier 1 and Tier 2 workloads

To the extent that you are already virtualizing Tier 1 and Tier 2 workloads, are you more likely to...?

100% = 121



As application owner comfort with virtualization grows, we expect to see more "mix and match" to optimize aggregate utilization

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

However, the growth stimulus from virtualization is more than offset by higher storage efficiency driven by increasing adoption of technologies such as thin-provisioning, de-duplication, incremental-only snapshots, and policy-based tiering of data.

IT organizations embarking on server virtualization often do not fully appreciate the large consumption of storage resources that ensues. In a blade server environment, for instance, every blade consumes an average of 1-2 TB of storage capacity. The objective is to only allocate physical storage as it is actually consumed. The current reality though with many of the traditional storage array vendors is that a large allocation is required. On average, an 8KB write initiates a 1 MB allocation. With the HDS Tagma, it even triggers a 42MB allocation. Hence, there is a risk that increasing virtualization exacerbates low storage utilization (currently 15-20% on average).

Vendors who have not invested in storage efficiency in a virtualized world will face pressure. EMC is one notable laggard in this area (outside of VMware of course) since it is not interested in disrupting its SAN cash cow business. **As 3PAR puts it, it's difficult** for an EMC rep to go into an account that bought 50TB last year and would have needed 80TB this year but instead sell them just 50TB again. 3PAR is one vendor who does enable high storage efficiency **and doesn't suffer from the baggage of a difficult business model transition** (but has other challenges, notably utilizing only direct sales as a channel).

We asked respondents (see previous survey exhibit) what US\$ amount they would estimate for storage spend avoided, because they are able to increase utilization on their existing storage capacity due to thin-provisioning, incremental-only snapshots, de-duplication, or because they are moving workloads to the cloud. Putting these numbers in relation to their planned spend for 2009 and 2010 yields a staggering result: **without increased storage efficiency, storage budgets would have to be 22-67% higher to accommodate data growth.** This illustrates the potential of these technologies to dent storage capacity growth.

Applications will increasingly embed storage management functionality, further reinforcing hardware commoditization but also reducing the need for dedicated storage management products.

This trend has material negative implications for all legacy storage array vendors. It also has more immediate negative implications for the leading storage resource management (SRM) products, notably EMC Control Center, Symantec CommandCenter Storage, and IBM Tivoli Storage Manager, all typically used to manage big heterogeneous SAN environments, though revenues in these are immaterial to their **parent company's overall business.**

Microsoft, Oracle and VMware in particular are driving a trend in the enterprise for storage decisions to be influenced by the applications, either business applications like Exchange or infrastructure applications (e.g., a database or hypervisor). For instance...

Oracle has aggressively integrated virtualization and the Linux kernel, clustering and HA capabilities, as well as storage management capabilities (via Automatic Storage Management - ASM).

With VMware, storage management is increasingly moving into the VirtualCenter management tool. Moreover, in December 2008 the company announced VMware View 3, which improves the management, scaling and personalization of virtual desktop environments by enabling IT to provision and update thousands of desktops from a single master image. This makes the differentiation which 3PAR and HP's LeftHand Networks enjoyed, namely to store de-duplicated VDI images very space-effectively, obsolete, hence reducing the **need for 'smart storage'**

The wider implication of this trend was highlighted in a December 2008 Forrester report *Do You Really Need A SAN Anymore? Dedicated Application Storage Proposes More Simplicity And Lower Cost*. Its author Andrew Reichman predicts that enterprise customers will move away from the cost and complexity of a single consolidated SAN for all the key applications to a world where enterprises will return to silos of storage assigned to and managed by specific key applications. This, he predicts, will enable utilization rates of 60% to 80% on lower cost and easier to manage commodity storage. The report points to early traction in the form of the Oracle/Hewlett-Packard Exadata system, Microsoft's recommendation of DAS for Exchange 2007, and VMware's increased storage management capability.

Another non-consensus factor depressing storage growth is the increased use of flash memory for caching in storage controllers.

For random reads, use of flash memory reduces the number of disk spindles required to deliver a certain level of read performance, potentially by as much as 50%. Since flash memory in the controller hides the latency of SATA, it also enables the use of much less expensive SATA disks in lieu of FC disks. SATA disks cost about half what FC disks cost on a per GB basis. This use case is relevant for the 25% of workloads which are performance sensitive applications that are read intensive. (There are also benefits for write-intensive applications.) Comparing two typical configurations, one with 16 FC disk shelves but no cache memory, and the other with 8 SATA shelves with 2 PAM cards (for a total of 32 GB memory), the second one yields a 32% lower cost while attaining the same performance level for random read workloads. Therefore, we believe use of flash memory for caching might enable average storage capex to be reduced by 8% (i.e., 25% x 32%), further reducing the growth rate projected in our Storage Demand Growth After Virtualization exhibit. (This is distinct from the notion of using SSD as expensive disk replacements).

Several factors though which we have not quantified might in turn provide a modest uplift to the growth rates shown.

First, de-duplication on secondary storage is accelerating the transition from tape backup towards disk-based backup. So for vendors without a legacy tape business (notably EMC and NetApp), that is a net positive.

Second, new use cases might emerge that drive storage growth. Two recent examples might illustrate the demand elasticity the industry experiences: a) incremental snapshots on primary storage, which are a good example of a storage efficiency technology, enabled customers to quickly recover their applications rather than having

to re-build from tape or from secondary storage. We have heard from NetApp customers for instance who keep several hours or days worth of work as snapshots on their primary storage. This provides business agility at a moderate cost and consumes more disks **in the process**. **EMC Symmetrix customers on the other hand, due to EMC's** less efficient implementation of snapshots (a snapshot is a full copy, not an incremental copy), tend to keep only 1-4 snapshots, with less agility. On a related note, without incremental snapshots, disks would have been too expensive for backup and tape would have remained more prevalent. Hence, incremental snapshots have not impacted storage capacity growth on primary and have actually had a positive impact on secondary due to accelerating the move away from tape.

Share shift drivers

This section highlights several share shift drivers, mostly related to workloads and associated storage technologies. In a nutshell, they should favor NetApp, HP (due to LeftHand Networks) and DELL (due to EqualLogic), while – in our opinion – providing only a modest positive for EMC.

FC SAN currently dominates the installed base of VMware deployments, mostly due to early VMware support for SAN over NAS. This is ironic though, given that virtualization started with tier 4 and 3 workloads. EMC is likely to defend its strong position in Tier 1 workloads which go for FC SAN, but is unlikely to stand out as a particular beneficiary of the trend towards iSCSI, though it has incorporated iSCSI across its product line including for Symmetrix, CLARiiON and Celera systems.

iSCSI is the storage technology that gains most from virtualization since it is well suited for the tier 2 and 3 workloads now being virtualized. This benefits the iSCSI market leaders, notably HP, Dell and NetApp. First, we expect the vast majority of DAS users to move to iSCSI, except possibly for Business Processing and Decision Support workloads better served by higher performance FC SANs. While a lot of players are pushing iSCSI, this should notably benefit Dell and HP given their recent iSCSI acquisitions of EqualLogic and LeftHand Networks, respectively, as well as their success with SMBs. NetApp will also benefit as users move from DAS to iSCSI due to its strong virtualization value proposition. Second, new deployments at customers that have SAN experience will likely be on iSCSI, providing modest uplift for EMC.

NAS, which has only been supported by VMware since 2007, should hold its own with customers currently running NAS environments, hence a moderate positive for NetApp and EMC. Overall though, we expect NAS market share to remain steady. NetApp will continue to see momentum in the enterprise market, which tends to buy from pure-play storage vendors, while Dell/EqualLogic and HP/LeftHand Networks will see strong momentum in the SMB market, which is experiencing higher growth than the enterprise.

These factors, notably the emerging role of iSCSI in virtual environments offsetting a decline in DAS, coupled with strong virtualization-related innovation, notably at NetApp, largely explain why mid-market and enterprise respondents highlighted EMC and NetApp as the key beneficiaries from these developments. They also explain why Dell

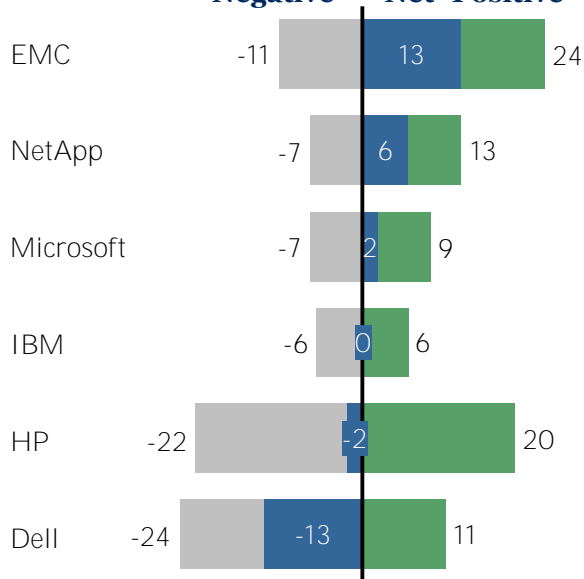
and HP (both with a legacy of DAS and not known for innovation in modular storage, except for recent acquisitions) received high negative as well as high positive ratings.

EMC, NetApp and – among SMBs – HP seem best positioned to take advantage of these trends

Respondents with >20 servers

n = 54

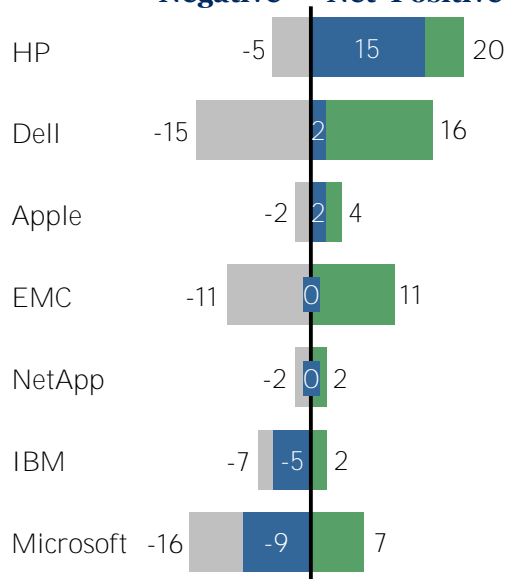
Percent



Respondents with 1-20 servers

n = 55

Percent



* Which storage vendor will benefit the most from the incremental storage spend that is driven by virtualization?

** Which of your existing storage vendors is most adversely affected by these utilization-enhancing technologies?

Note : Net equals percentage of respondents with a Positive opinion minus those with a Negative opinion

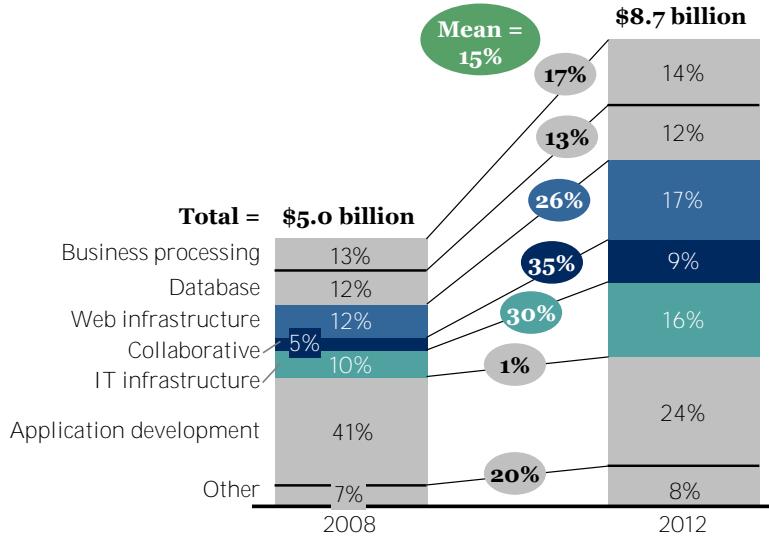
Source : TechAlpha online survey of US IT executives conducted November 10-30, 2008

A starting point for understanding the share shifts in storage is to examine the trend in Tier 2 and Tier 3 workloads being virtualized.

Virtualized Web, collaboration, and IT infrastructure workloads also drive growth in storage spending

Storage revenue driven by virtualization by workload tier

(%) CAGR



Note: **Workload definitions:** *Business processing* – ERP, CRM, OLTP, Batch; *Database* – database; *Web infrastructure* – Streaming Media, Web Serving; *Collaborative* – E-Mail, Workgroup; *IT infrastructure* – File & Print, Networking, Proxy/Caching, Security, Systems Management; *Application development* – Test & Development; *Other* – Decision Support (Data Warehousing/Mart, Data Analysis/Mining), VDI, Technical, Industrial R&D

Source: TechAlpha analysis based on IDC data

Both collaboration and web infrastructure (e.g., media streaming) might benefit vendors with strong file storage franchises – notably EMC and NetApp’s NAS businesses.

Qualitatively, virtualization will benefit iSCSI and, to a lesser extent, NAS.

Primarily, virtualization will further accelerate the trend towards iSCSI:

- Inherent cost per GB advantage over Fiber Channel SAN.
- Performance characteristics well suited to Tiers 2 and 3 workloads now being virtualized (while Tier 1 calls for higher performance FC SAN).
- Server administrators are more familiar with iSCSI since it runs over TCP/IP and Ethernet and because of familiarity with iSCSI since original implementation in Windows Server 2003. Ethernet expertise is already available in every organization, while FC requires specialized FC networking expertise and may raise interoperability questions.

Secondarily, virtualization may benefit NAS² due to scalability, control, manageability, utilization, and cost advantages over FC protocol over NFS (network file system used for NAS).

This is reflected in the share gains expected for iSCSI and – to a much lesser extent – NAS³ in virtualized environments.

2 NAS benefits in virtual environments include the following: Scalability: All VMFS traffic goes through the same I/O path to the LUN; hence performance decreases as the number of FCP connections increases. NFS does not suffer from the same constraint, hence many more ESX servers (and hence VMs) can share a single data store. Performance and control: Raw Device Mapping is cumbersome to manage on SANs. It is used for instance to add or migrate raw LUN storage or better enable distributed file system features. **Technically, customers tend to use VMFS for/on top of FC SAN/iSCSI, or VMDK's mounted as NFS** volumes. Manageability: NFS data stores can be dynamically resized while all the VMs remain online. NFS also offers the quickest way to recover a VM from a snapshot and enables single file restores. Utilization: Space savings from de-duplication are visible and hence usable by the VMware admin. VMDKs are notoriously space-inefficient. Cost: On a FC SAN every ESX host requires a FCP HBA.

³ The use case for NFS (and by implication NAS) of course has expanded much beyond serving end user home directory files. The technical computing workloads, such as electronic design automation (i.e., for applications by vendors such as AutoDesk or Dassault Systèmes) and geospatial data (e.g., exploration of

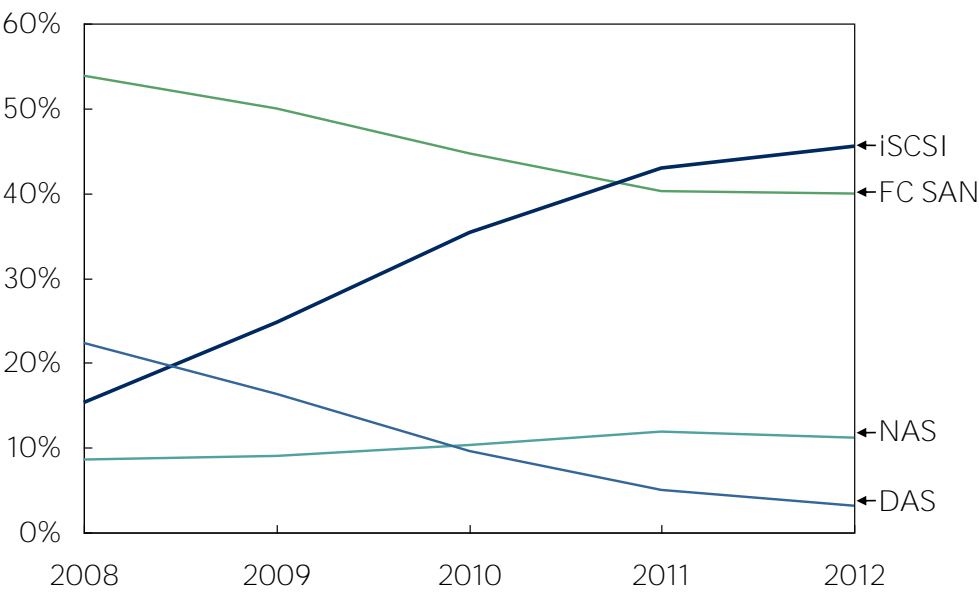
Quantitatively, iSCSI grows strongly.

iSCSI will gain share across both non-virtualized and virtualized environments. Importantly, iSCSI market share (i.e., relative to FC SAN and NAS) among virtualized workloads is expected to be double that among non-virtualized workloads. Thus, iSCSI will account for the majority of virtualization server licenses by 2012 across practically all workloads, unseating FC SAN from its current leading position. This will also translate into iSCSI accounting for the leading share of storage revenue, though the effect is slightly less pronounced due to the price premium of FC SAN over iSCSI.

natural resources) are using NFS. Importantly, these are among the wave of earlier and current adopters for virtualization, thus providing a boost for NAS vendors. Finally, about 10% of all Oracle database workloads across vendors are using NFS, including a vast majority of Oracle deployments on NetApp. VMware functionality is built on VMFS (a file system) originally designed for FC SAN and which only started supporting NFS in 2006. While we expect VMware to improve VMFS scalability for SANs over time, in the interim this should moderately favor NAS vendors.

iSCSI is the biggest storage technology share gainer in virtualized environments

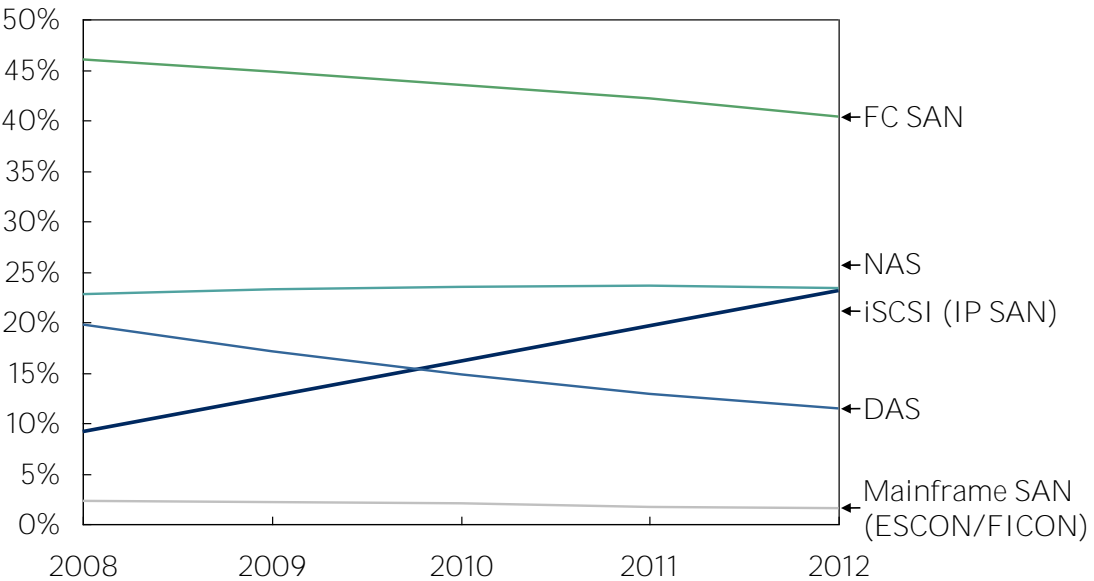
Market share (new shipments by value) in virtualized environments



Source: TechAlpha analysis based on IDC data

iSCSI is also the biggest share gainer in the broader market

Market share by volume (petabytes) across virtualized and non-virtualized environments



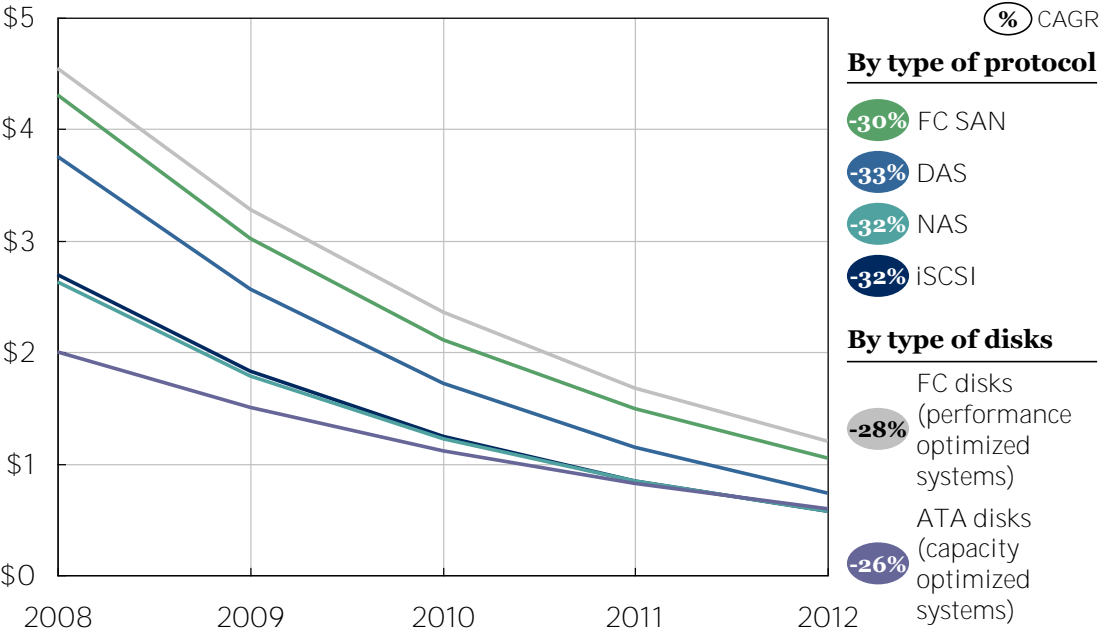
Source: IDC

Growth for iSCSI is driven by lower cost (and complexity) than FC SAN and DAS.

While there is continued price erosion on a dollar per GB basis for all technologies, iSCSI is a technology with a structural cost advantage, partially due to being able to run over regular IP connectivity (assuming sufficient network quality) without the need for a dedicated HBA/switch/network, and partially due to its lower operational complexity (presumably not reflected in the chart below).

Storage pricing by type of storage system

\$ per GB



Source: IDC

While the pace of price decline has been relatively uniform across protocols and disk technologies, the exhibit also shows a substantial cost difference between FC and ATA disks.

What is new, however, is that a share shift is happening away from expensive FC disks to cheaper SATA disks.

Traditionally, FC disks have been used in situations requiring high IOPS (i.e., inputs and outputs per second) coupled with low latency typical of situations with random reads

and random writes (i.e., read or write anywhere on the disk at short notice). OLTP database deployments are a typical example.

ATA or Serial ATA disks on the other hand have been used for sequential workloads, such as delivering video streams or writing to secondary storage for backup purposes, or writing to tertiary storage for archival purposes. A database use case well suited for SATA is data warehousing since it generates large sequential I/O and is less sensitive to disk latency.

Two factors are now driving the SATA share gains:

First, server virtualization with its attendant shift to networked storage will fuel demand for secondary and tertiary disk-based storage. In other words, more workloads will need to be backed up, and disk-based backup and archival is growing much faster than primary storage.

Second, SATA disks may see more usage for primary storage because technological advances make SATA usable for random I/O situations. In particular, flash memory and solid state storage can be used as caches in the storage controller. This reduces the latency for I/O-intensive operations since data can be served from the cache memory as opposed to directly from disks. Hence, the inherent latency of the SATA disks does not slow down the application.

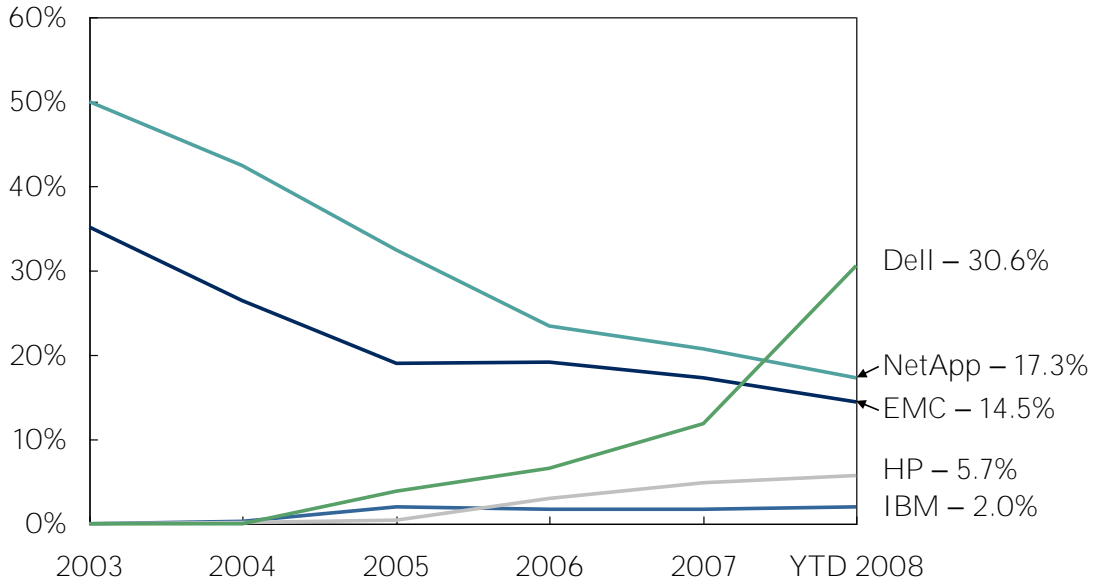
As a result, capacity-optimized (SATA) disk shipments are growing at rate of 75.8%, whereas performance-optimized disks (FC Disks) are growing at 32.3%.

DELL and HP are the biggest beneficiaries from iSCSI.

Strategically, both DELL's and HP's acquisitions are well suited to offset the impact of their large declining DAS business. (Note the exhibit below does not yet reflect HP's acquisition of LeftHand Networks.)

Market share (in value) by protocol – iSCSI

YTD represents the first 2 calendar quarters (January-June)

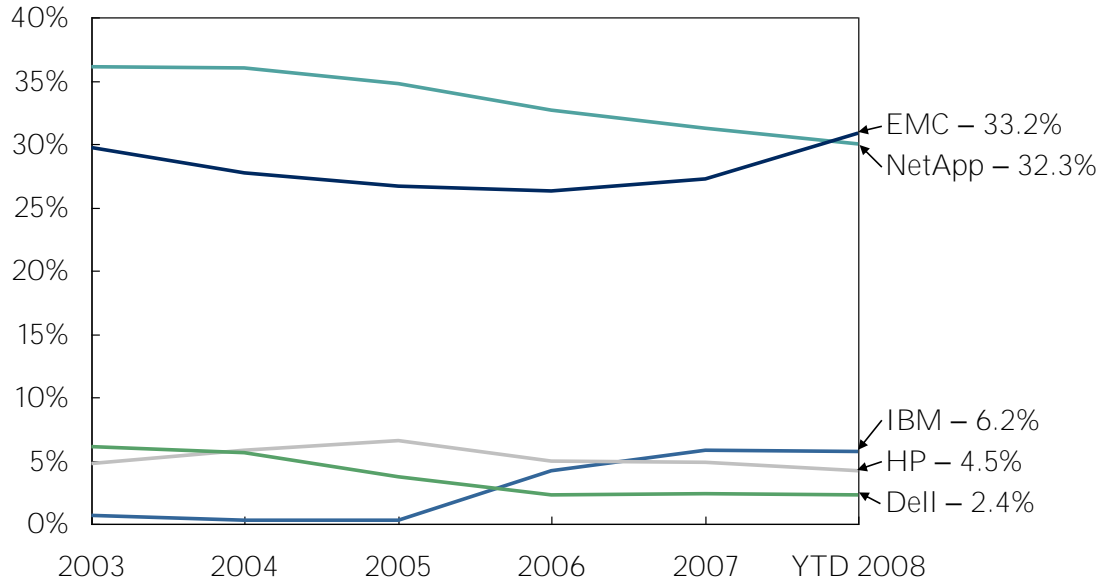


Source: IDC, September 2008

The secondary, much less pronounced trend towards NAS benefits both EMC and NetApp.

Market share (in value) by protocol – NAS

YTD represents the first 2 calendar quarters (January-June)
NAS represents IDC's estimation of the NAS market less CAS revenue



Source: IDC, September 2008

Vendor SWOT analysis

A qualitative analysis of vendor strengths, weaknesses, opportunities, and threats in this new world adds further insight on why larger companies in our survey saw EMC and NetApp as being the biggest beneficiaries, while smaller companies look towards HP and DELL.

SWOT for NTAP

We like NetApp's capabilities around storage efficiency as well as iSCSI and believe they are well positioned for a world where customers use multiple hypervisors. NetApp claims customers can cut capacity requirements in half when using its storage efficiency features and even offers a guarantee around this. We are concerned though about NetApp's potential vulnerability to a closer relationship between EMC and VMware, though in today's more competitive hypervisor market VMware should be reluctant to show any favorites among the storage vendors. On the up-side, NetApp should be able to position itself as the storage vendor of choice for Microsoft HyperV and XenServer environments since it embraces a multi-hypervisor world evidenced by its early integration with Citrix.

Storage vendor SWOT analysis: NetApp

Strengths

- Leadership in NAS and high-growth iSCSI markets
 - NFS has been shown to be more scalable and more easily manageable – critical for large deployments
 - iSCSI leadership positions them well for growth in Tier 2 and Tier 3 workloads
- Good storage efficiency, which should resonate with capex-constrained customers
 - Low space overhead for data protection – 14% for RAID-DP vs. 28% for RAID-10
 - Supports de-duplication on primary and secondary, resulting in as much as 90% space savings
 - Thin-provisioning available across all platforms
 - Space recovery allows resizing of volumes
- Well positioned for a world where customers use multiple hypervisors. Notably, first and only vendor so far with **“one click” storage integration for Citrix XenServer**, allowing customers to centrally manage storage configuration and provisioning from a single console
- Other virtualization-relevant differentiators
 - Rapid cloning for virtual server provisioning
 - Low performance overhead for snapshots
 - Unified storage architecture that is easy to manage

Weaknesses

- Risk that NetApp might be **“stuck in the middle,”** though mitigated by history of innovation
 - Low market share in FC SAN and Tier 1 workloads
 - iSCSI solutions higher priced than EqualLogic and Compellent
 - Perception is that EMC has preferred status with VMWare
- Relies more on new accounts to continue to grow than vendors with broader installed base (EMC, HDS, IBM) – which might present a larger challenge in a recession

Opportunities

- Establish itself as the storage vendor of choice for Microsoft HyperV and XenServer, to counter EMC
- Support for vStorage APIs to makes it easier for customers to use FlexClone, Snapshots, thin-provisioning through the VMWare Virtual Center

Threats/ concerns

- Vulnerable to a closer relationship between EMC and VMWare
- Dell/EqualLogic might bundle storage with virtualization software and servers on attractive terms

SWOT for EMC

EMC's strengths are undoubtedly in its large installed base and credibility in high performance workloads. Its primary weakness is a slow pace of innovation in the core **storage market**. EMC's capabilities vary across its heterogeneous product lines. In particular, we are concerned that its product deficiencies in terms of enabling high storage utilization are especially acute in virtual environments. Its DR solutions are generally known as more complex and expensive.

The biggest opportunity we highlight is tighter integration with VMware following the change of leadership at VMware. This could include joint go-to-market activities as well as product integration once VMware releases vStorage **APIs in 1H'09 (timed with VI-4)**. (In principle, though, the vStorage APIs will be available to all storage vendors and VMware will be loath to identify favorites among the storage vendors). It would be ironic if one side benefit of the VMware acquisition turns out to be unified provisioning and management of disparate EMC storage product families via VMware. Another notable but unlikely opportunity is for EMC to orchestrate a broader data center management solution that is uniquely suited across virtual and physical environments and is more application-aware than what is provided today by the big 4 systems management players (IBM, HP, CA and BMC) as well as Microsoft.

One of the notable threats for EMC is from the advent of lower cost, modular storage, **given the company's slow pace of innovation and evolution in the core storage market**.

Storage vendor SWOT analysis: EMC

Strengths	<ul style="list-style-type: none">• Largest stand-alone storage vendor<ul style="list-style-type: none">– Leader in FC SAN with proven solutions for Tier 1– Powerful GTM capabilities with global reach• Majority stake in VMWare drives customer perception (not currently a reality) of superior product integration
Weaknesses	<ul style="list-style-type: none">• Product deficiencies in terms of enabling high storage utilization are particularly acute in virtual environments<ul style="list-style-type: none">– Thin-provisioning is essential to reign in storage consumption driven by VM proliferation. The feature is available for Celerra (i.e., iSCSI and NAS), but lacking in FC products (i.e., Symmetrix and CLARiiON)– Virtual Server provisioning via rapid cloning is only available in Celerra– De-duplication only available for disk-based backup (Avamar), but not for primary storage– RAID-10 uses twice as much disks as RAID-6. Supports RAID-6, but impacts performance• Complex and expensive DR solutions. For instance, CPU performance drops by 50% when EMC runs snapshots
Opportunities	<ul style="list-style-type: none">• Tighter integration enabled by new VMWare management<ul style="list-style-type: none">– Sales & Marketing– Unified provisioning and management of disparate EMC storage product families via VMWare– Product integration once VMWare releases vStorage APIs in 1H'09 (timed with VI-4)• Improve storage efficiency<ul style="list-style-type: none">– De-duplication on primary storage– Thin-provisioning across product lines
Threats/ concerns	<ul style="list-style-type: none">• EMC not a leader in cost-effective storage to support virtualized Tiers 2 and 3 workloads<ul style="list-style-type: none">– EqualLogic (Dell), LeftHand Networks (HP), Compellent, and NetApp seen as leaders in iSCSI– Storage efficiency more important in virtualized environments

SWOT for DELL

Clearly DELL is one of the leaders in and beneficiaries of the trend towards iSCSI. As the exhibit below illustrates, the biggest question will be whether DELL wants to and is successful in driving innovation in this area post-acquisition, in particular so that the EqualLogic offering becomes more relevant to mid-sized and large customers. Secondly, EqualLogic will be both constrained by as well as taking advantage of **DELL's changing GTM strategy, in particular DELL's new-found emphasis on channels.**

Storage vendor SWOT analysis: DELL (includes EqualLogic)

Strengths

- Perceived as low price leader
- All software features are enabled and included in the base code
- Single, simple architecture drives ease of use
- Longstanding and successful EqualLogic relationship with VMware

Weaknesses

- EqualLogic product line only scales to mid-range requirements. Shortcomings include...
 - Lack of data de-duplication
 - Performance overhead with snapshots
 - Limited ability to upgrade from one platform to another
 - Only supports active-passive cluster failover, not active-active
- Ambiguity in product positioning, e.g., MD3000i entry system vs. DELL/EMC AX5 vs. DELL/EqualLogic PS systems vs. DELL/EMC CX3 series. In particular, **EqualLogic's iSCSI products compete with EMC's CLARiiON CX product family, which DELL is re-selling under the DELL/EMC brand**

Opportunities

- Continued growth in server virtualization will continue to increase addressable market for iSCSI
- Leverage thin-provisioning and replication capabilities delivered through iSCSI, as an alternative to expensive FC SAN alternatives
- Expansion of channel presence

Threats/ concerns

- Competition from LeftHand Networks, particularly internationally and at the entry level. EqualLogic has lost many channel partners to HP/LeftHand Networks after its acquisition by direct-centric DELL

SWOT for HP

We see the acquisition of LeftHand Networks by HP as a well-timed and defensive move, **in particular to transition HP's ageing DAS franchise over to iSCSI. As the exhibit below demonstrates, though, most market participants are skeptical of HP's commitment to leadership and innovation in storage.**

Storage vendor SWOT analysis: HP (includes LeftHand Networks)

Strengths

- Ability to provide one stop shop solutions across systems, storage, software and services. An **example would be HP's ProLiant server line** whose active remote hardware management capability is pre-integrated with Citrix and VMWare
- **Global reach in sales and services, with HP customers and partners described as 'very loyal'**
- LeftHand Networks acquisition brings much needed iSCSI capabilities
 - Good market traction with 3,000+ iSCSI customers
 - Well-positioned for virtualization with up to 80% of LeftHand deals linked to virtualization projects
 - Innovative high-value software includes thin provisioning, remote replication, Snap & Clone and SmartClone capabilities

Weaknesses

- Seen as lacking strategy, innovation and up-to-date home-grown product portfolio in storage
 - In deals, tends to lead with (blade) server offerings and drag storage to expand deal size
 - **Gartner describes storage product line as 'just good enough' when selling to application owners**
- Open question whether LeftHand Networks will find adoption among larger customers
 - **Role in HP's portfolio is to keep customers moving off DAS, vs. net new storage system sales**
 - Positioning versus its other mid-range products (AiO, EVA, MSA) may be confusing
 - Potential for channel conflict between server resellers promoting HP ProLiant servers bundled with SAN/iQ software, and LeftHand storage resellers

Opportunities

- Continued growth in server virtualization will continue to increase addressable market for iSCSI
- Clarify product positioning within iSCSI portfolio following LeftHand acquisition

Threats/ concerns

- **LeftHand solution will end up competing at the low end with Microsoft's WUDSS with iSCSI connectivity, running on Microsoft HyperV**

Economics

Impact of emerging technical and architectural changes

Capacity savings from storage efficiency technologies translate directly into lower capex spend, since these technologies are generally not priced at a \$ per GB premium.

To the best of our knowledge, none of the large storage vendors charges an explicit price premium for thin provisioning and de-duplication features. Therefore, \$ spend tracks PB purchased.

In fairness though, different vendors and vendor product lines provide noticeably different storage efficiency. In a closer look at the two stand-alone vendors NetApp and EMC, NetApp wins out:

Snapshots on EMC's Symmetrix are full copies of the data, thus each snapshot consumes 1x the space of original volume. NetApp on the other hand is known for low-overhead snapshots, encouraging customers to keep more snapshots around (for better RPO and RTO)

A vendor's RAID implementation affects space utilization is the. RAID 6 for instance only 'wastes' 14% of storage capacity to achieve a given level of data protection. **NetApp's implementation of RAID 6, called RAID DP,** is an example. EMC on the other utilizes RAID 10 (or RAID 1) **for the same level of resiliency, 'wasting'** as much as 50% of the storage capacity in question.

From a product perspective, there is an emerging battle over value-add between the storage array vendors and the virtualization vendors.

Storage solutions are becoming increasingly integrated with the server virtualization software management layer. This enables improved manageability. The server administrator can manage the entire infrastructure without the storage administrator becoming a bottleneck, though the storage administrator ideally can centrally enforce policy. This new approach to management is done through a server administrator user interface and programmatic interface that can leverage the underlying capabilities of the storage systems.

Storage switching costs are reduced because the same basic functionality is provided through the same interface, regardless of the underlying storage.

In particular, server administrators can control and capture many benefits of the underlying storage functionality, such as snapshots and replication, without familiarity with the various native storage tools.

This will increase pressure on storage vendors to keep up the pace of innovation, a notable negative for IBM, HP, and HDS.

In addition, in a demonstration of how power is shifting, storage vendors increasingly have to do the work to integrate their systems with VMware today, and likely Citrix and Microsoft tomorrow. Traditionally, a third party vendor seeking integration like Symantec had to do the work itself.

The examples below illustrate the potential of virtualization vendors to compete with storage vendors when it comes to managing storage resource pools, as well as to either highlight or mask functionality provided by these vendors. Clearly the intent for vStorage API is to drive as much native storage management functionality as possible out of the VMware interface.

Value add of storage array vendor vs. virtualization vendor

Specific functionality examples illustrate the potential competition posed by the virtualization vendors, while highlighting existing complementarities

- **Thin-provisioning – complementary, with only a limited set of tasks performed via VMware**
 - **VMware:** vStorage integration enables a VMware-trained server admin to perform basic storage management tasks from the VMware interface, such as resizing storage volumes to free up space when a VM is deleted, or ‘thinly provisioning’ (i.e., reducing the size of) a VMDK file
 - **Storage vendor:** Allows customers to improve utilization by resizing storage volumes as well as by making physical storage pools appear larger than they actually are, i.e., true thin provisioning
- **Snapshots and Cloning – competing for Tier 3 workloads**
 - **VMware:** Snapshots or cloning of entire VM or individual files can be used to restore the VM on the same or different server. Because the process consumes server CPU and IO cycles, it is typically set to run every few hours not every few minutes. The resultant high RPO (Repair Point Objective, i.e., maximum data age desired for recovery) tends to suffice only for lesser workloads
 - **Storage vendor:** Snapshots taken entirely on storage, requiring no server CPU or IO cycles, enable high availability. Performance overhead on storage sub-system varies across storage vendors
- **Backup and Restore – starting to compete in SMB space, potential to compete in apps B/R**
 - **VMware:** Consolidated Backup (VCB) can offload backup of entire VM to a proxy server not solely dedicated to this task, generating additional network traffic in the process. Offsite archival is not currently supported. Does not presently take advantage of (inherently more efficient) snapshots at storage layer. In the future, once applications running in virtual environments store their user data in the VM, application-specific backup modules will no longer be required
 - **Storage vendor:** Snapshot-based backup and restore provides more granularity (e.g., enabling file level restores and more frequent snapshots), is faster, and supports offsite archival

The implication from this analysis is:

Functionality emerging in the virtualization layer will commoditize and make obsolete a good part of what is today differentiating functionality provided by storage vendors.

Let’s expand the backup and restore example above to understand the implications. A near-term step in the roadmap for VMware Consolidated Backup (VCB) is undoubtedly integration with storage vendor-specific snapshotting capabilities. The consequence of this will be that customers will no longer have to rely on storage vendor add-on products (such as NetApp’s SnapManager for Virtual Infrastructure) to get better performance

and snapshot granularity than can be achieved natively with VCB. In the medium term, though, we also expect that more applications running in virtual environments will embed their user data in the VM. The consequence, more material in \$ terms than the first step, is that application-specific backup modules will no longer be required. Today, these modules are provided both by the application and database vendors as well as by the storage vendors. At NetApp, for instance, this would negatively affect SnapManager for Oracle, SnapManager for SQL Server and SnapManager for Exchange. Finally, we would not be surprised to see VMware also incorporating de-duplication, having already announced cloning, further eroding the value of what are today differentiating features in storage.

Impact of emerging business models

Differentiation between the storage vendors today is largely in the software that delivers the advanced functionality listed above. However, the Data Center Automation capabilities being built by VMware and Microsoft and the Big 4 will increasingly hide that. They are each working to make servers, storage, and networks look like a single, large, increasingly homogenous pool of resources that can be allocated to applications with ease. Declining differentiation and the shift in value to the Data Center Automation layer will compress margins over the next 3 years.

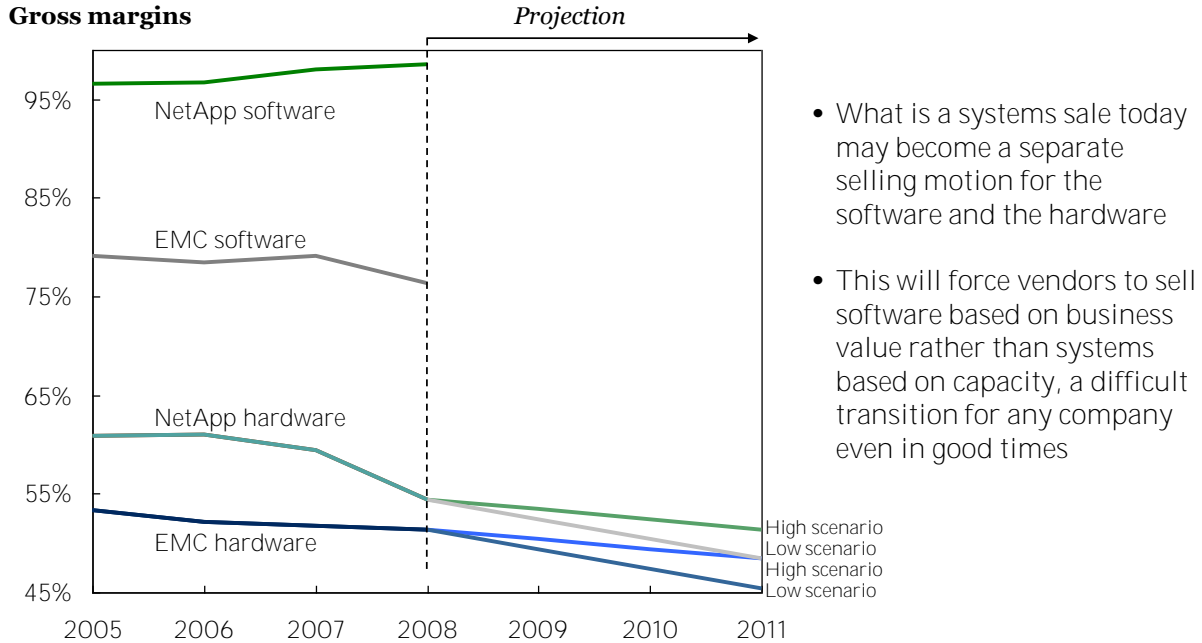
By far the most fundamental change will be that storage vendor business models are going to have to go from selling systems to selling software plus hardware separately.

This is historically a difficult transition. Modular hardware is emerging in the form of commodity disks, augmented by flash memory for performance, and controllers increasingly built on commodity x86 servers. It is influencing customers to insist on competitive pricing on the hardware, forcing vendors to sell software based on business value rather than systems based on capacity. While in principle this might yield the same aggregate gross margin – lower on hardware, higher on software – we expect very few vendors will be able to master the transition to selling value in the software, hence leading to lower overall gross margins.

If software gets unbundled completely, the economics of existing high-cost, direct sales organizations break down. The sales model transition will most impact the server vendors (i.e., HP, SUN, and IBM) who are used to selling big iron storage (HDS in this case) without highlighting the innovation in software. While we do think customers will continue to value the integration that one vendor can provide (e.g., management of one global name space, integrated provisioning, ease of snapshotting and replication), it does illustrate the pressures, even more so as the less innovative vendors in an account have little choice but to differentiate on (hardware) price.

Early evidence of the hardware commoditization trend can be seen in the erosion of hardware gross margins that has set in at some storage vendors over the last 18 months.

Storage hardware economics may come under pressure



Note: EMC: 2008 includes 9 months to September 30. Hardware consists of Information Storage as reported, Software consists of Content Management and Archiving, RSA Information Security and VMWare as consolidated.

NetApp: 2008 includes 6 months to October 24. Calendar year numbers shown based on fiscal year ending April of the subsequent year without normalization

Source: TechAlpha analysis based on SEC filings

A good illustration of the hardware versus software shift is how NetApp repriced its hardware relative to its software earlier in 2008. This past year, NetApp reduced list prices on hardware, possibly explaining the decline in hardware gross margins reported. At the same time, software list prices have kept constant but discounting on software has been restricted severely, thus putting more onus on the sales force and channel partners to articulate the value in software, clearly an area where NetApp is known as an innovator. Apparently this shift was triggered by customer complaints that NetApp sells commodity hardware at a high dollar per GB cost – **higher in fact than EMC's CLARiiON**, which is used for FC SAN and more recently also for iSCSI SANs.

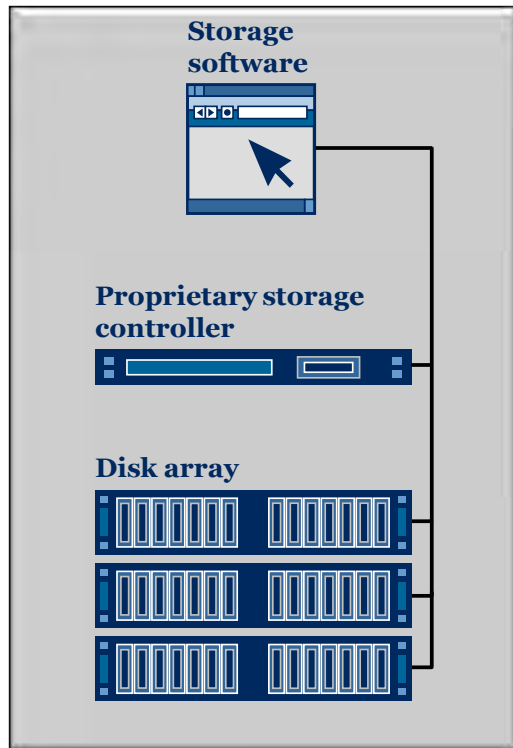
The implication is that vendors who are slow to innovate at the storage software layer stand to see margin compression. Notable examples in this category include Hitachi and (outside the LeftHand Networks division) HP.

By far the most impactful trend will be the standardization and commoditization of storage hardware, which risks up-ending the existing business models of the storage vendors.

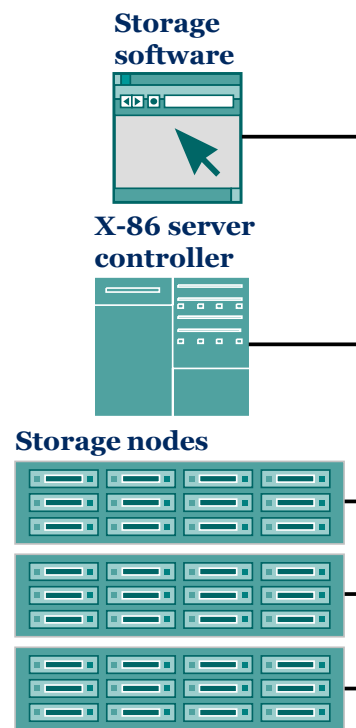
What is a systems sale today becomes a separate selling motion for the software and the hardware. In particular, modular hardware is emerging in the form of commodity disks, augmented by flash memory for performance, and controllers increasingly built on commodity x86 servers. This will force vendors to sell software based on business value rather than systems based on capacity, a difficult transition for any company even in good times.

The progressive commoditization of modular storage

Monolithic

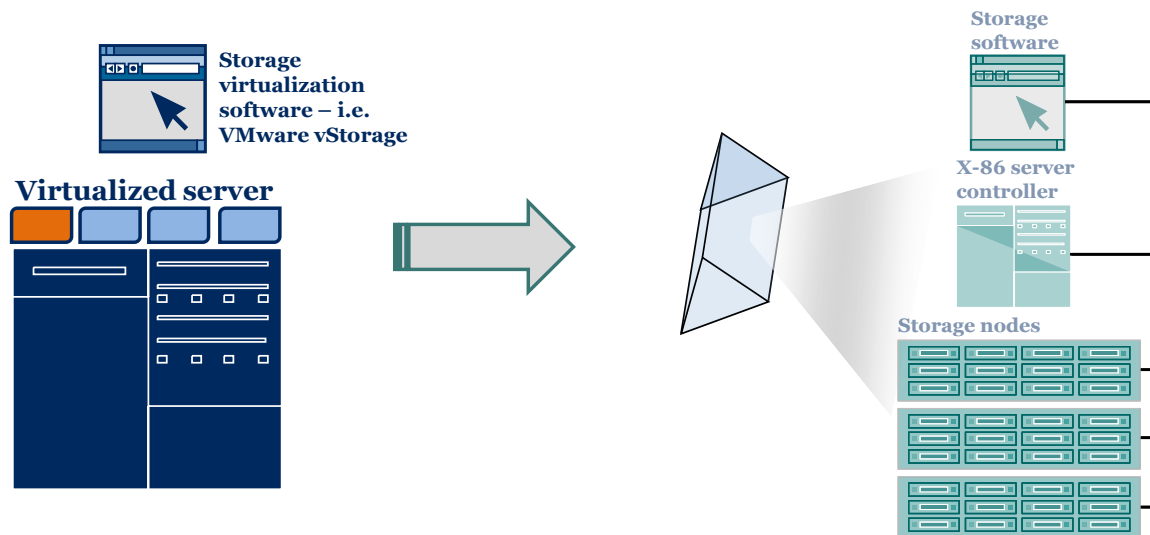


Modular



As we illustrated earlier, virtualization software risks masking the differentiation between storage vendors.

Virtualization software masks differentiation of all but the leading edge features of the underlying storage, contributing to the commoditization of storage



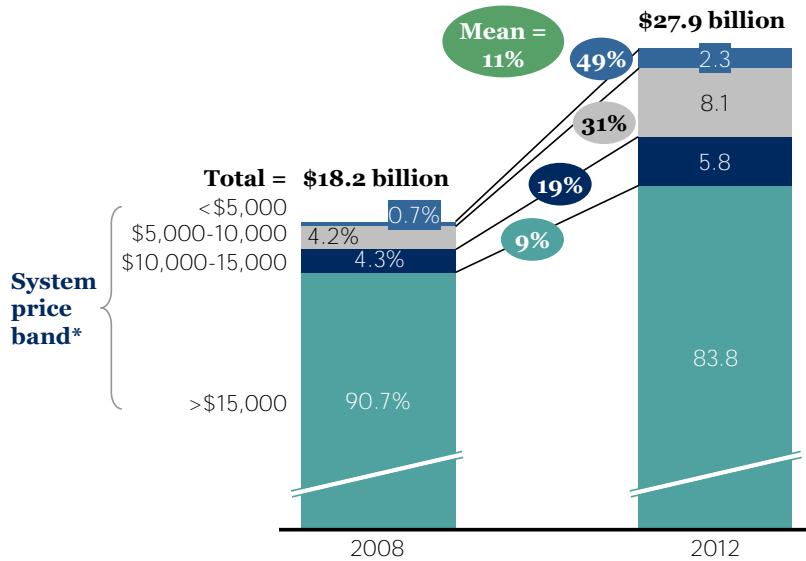
- Server virtualization software increasingly has storage functionality built into it that maps to the traditional storage system functionality
- This virtualization software increasingly makes the underlying storage look alike across vendors
- **It's not a complete masking, because vendors with the most innovative features or best implementations can still differentiate themselves somewhat**
- However, the switching costs between vendors declines

Incidentally, though not tied into virtualization in particular, this is complemented by a notable growth in low end systems.

Growth in low-end systems – though from a small base – is an early indicator of commoditization trend

Market growth by segment

(%) CAGR



* External networked storage, i.e., SAN plus iSCSI plus NAS, excluding DAS. System price is composed of the actual platform (storage controller), the disk type (FC or SATA), the connectivity (FC or GigE), redundancy (dual controller or single controller) and the disk capacity shipped with system

Source: TechAlpha analysis based on IDC data

Commoditization pressure from within the storage industry is also creating a downward pull on margins.

Low-cost technologies such as iSCSI and advanced software from vendors, such as HP's LeftHand Networks and Dell's Equallogic, are climbing the performance curve faster and addressing a steadily greater share of customer requirements than their more expensive peers.

A further example of the pressure on hardware margins is illustrated by SUN's recent announcement. SUN, mirroring its efforts in open source server software, has just introduced a range of storage arrays that claim to undercut existing vendors by bundling the software "for free" with the hardware. **Let's examine a specific example configuration:**

The SUN OSA 7210 competes with the NetApp FAS 2020.

SUN's OSA 7210, which is bundled with free software, costs \$35,000. That is roughly **20% more expensive than NetApp's FAS 2020, which is priced at \$29,000 for an** analogous 12 TB SATA disk configuration. NetApp provides only some software for free (snapshots and "FlexVol" thin-provisioning).

We would expect a typical customer to be interested in SnapRestore at a minimum, in addition to thin-provisioning and snapshots. The \$3,000 list price for SnapRestore **reduces NetApp's price advantage to some 10%.**

Customers who also need the popular FlexClone4 (\$8,000) and SnapMirror5 (\$5,000) capability though, would end up paying almost 30% more for this innovative functionality than for the SUN system.

⁴ FlexClone'ing replicates data volumes, files, and LUNs as instant virtual copies and can be used, among others, to facilitate instant, scalable provisioning for virtual server and desktop environments.

⁵ An efficient way of replicating only changed data blocks to a disaster recovery site, avoiding unnecessary storage and bandwidth consumption

As a caveat, it should be said that the commodity storage trend will be most acute soonest for mid-tier workloads, i.e., those which do not require the highest level of availability, resiliency and fault tolerance. Time-tested RAID implementations such as RAID-DP for instance provide double parity data protection much more space-efficiently than some of the recent **‘software with commodity hardware’ approaches (e.g., LeftHand Networks)** which tend to use replication/mirroring for high availability. **Another example of the ‘commodity approach’ is the use of flash memory on the server** itself for caching purposes, which provides much lower fault tolerance than RAID-based storage systems. Nonetheless, we do expect these trends to reinforce discounting pressure on storage vendors.

We believe the outlook for storage is a world where vendors are changing storage into a service that securely delivers data and capacity on-demand according to user-specified price and performance levels. This service can be delivered on-premise using new **systems or in emerging “public clouds.”** Some high-growth customers, particularly online service providers, are building their own clouds. That accelerates commoditization due to the tremendous storage purchasing volume these operators aggregate as well as their tendency to rely on in-house storage management tools.

The inherent conflict between EMC and VMware is likely to become visible over the next year. VMware can either commoditize EMC’s core business or become its ultimate salvation.

EMC does not want VMware to accelerate storage commoditization through its internally developed software or through potential acquisitions, such as the missed opportunity to buy LeftHand Networks, which HP picked up recently. However, one of its best hopes for moving up the value chain away from commodity storage is to hang onto VMware. Amazon represents a stark example of what is in store for EMC if it does not own the virtual data center management layer. In its most recent contract win with Amazon for additional storage capacity, EMC had to bid at or near cost. Software running on **Amazon’s virtual** infrastructure cannot see and does not **care which vendor’s** storage equipment is underneath. Its recently announced Atmos cloud storage management software also represents a large growth opportunity, but it is not applicable to the enterprise.

VII. Implications for Server Software Vendors

Key vendor takeaways

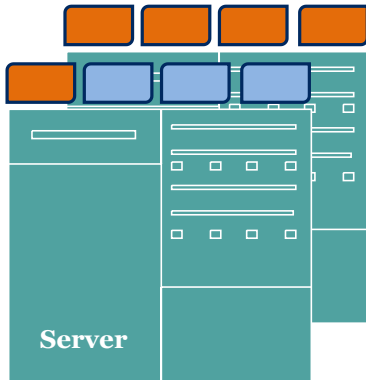
Server infrastructure software vendors, particularly IBM, Microsoft, and Oracle, will see customers purchase materially less software upfront. In addition, vendors will potentially have to move closer to a subscription pricing model. Either transition, but especially both, would be disruptive to their current business models.

The growth rate of new license revenue and associated maintenance streams for server software (excluding enterprise applications and Windows Server) will be less than expected over the next 24 to 36 months as less capacity is bought upfront. Licensing in an on-demand world enables customers to buy and deploy “just in time” instead of “just in case.”

Licenses today for the most part are allocated to and “fused” to a physical box in perpetuity. Because the software is hard to move in terms of license restrictions and provisioning time, vendors, starting with IBM, acknowledge that customers buy far more capacity than they need under the server or processor-based licensing model. That model is far more prevalent than the concurrent or named user models according to IBM. Customers find it hard to budget for concurrent use because of the potential for variability, and named users may involve a high number of users with more casual reporting access.

The three predominant pricing models for server software

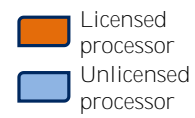
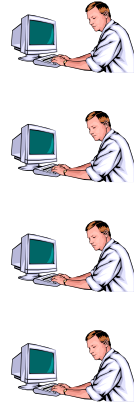
Resource-based pricing: by processor or by server



Concurrent user



Named user

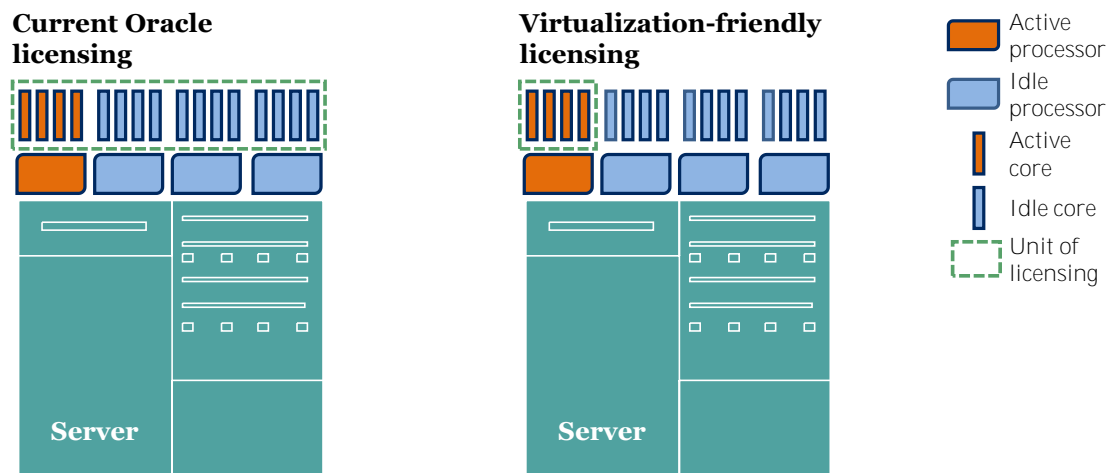


- According to interviews with IBM, the large majority of server software pricing is resource-based

Source: TechAlpha analysis

So customers are left with the problem of having to buy extra software for an underutilized server. That underutilized server was the very problem server consolidation via virtualization was meant to solve. However, this part of the problem is related to software licensing, not virtualization technology.

Average database server utilization 5-20%*: Creates pressure to improve the way server consolidation improved server utilization



- Traditionally, servers were vastly underutilized, because it's very cumbersome to move software to a bigger machine once installed
- Therefore, administrators typically over-provision the machine, so the software can grow into the capacity over 3-4 years

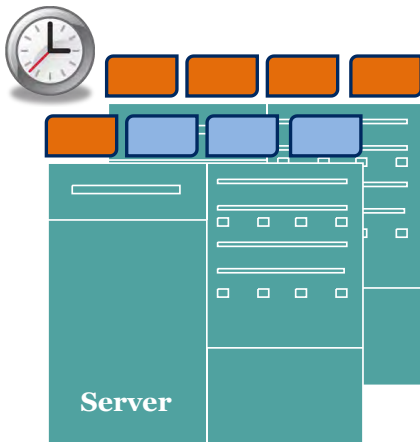
Source: TechAlpha analysis

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The limits of dynamically adjusting capacity with current technology have created some startling anomalies. Customers repeatedly told us they forward purchase excess capacity of 3 to 4 years per server when sizing server hardware and software. Anecdotally, we have been told this practice is true for applications such as Microsoft Exchange as well. Average Oracle database utilization per server, as measured by EMC across some of their largest customers and detailed in a presentation at VMworld 2008, is 5%. In IBM's explanation of its virtualization-friendly pricing using sub-capacity logical partitions, it claims average database server utilization across its customers is 5-20%.

Virtualization enables just-in-time purchase vs. just-in-case

From partial use of processor cores to full cluster for X hours



Active processor
Idle processor

- Virtualization upsets processor-based pricing of databases, middleware and other server software by enabling operational flexibility that calls for server software pricing in increments of time and capacity
- In this example, an application grows from 1 processor to 4 on a different server to accommodate a short-term spike

Source: TechAlpha analysis

In the future, as virtualization brings Amazon-like private clouds to the enterprise, customers will increasingly demand the ability to allocate on demand discrete increments of capacity for discrete increments of time. This model mimics exactly what Amazon Web Services uses today, both for Linux as well as Windows with SQL Server. When Microsoft introduced Windows Azure, they also indicated that their entry-level pricing would follow the same model.

Pure on-demand pricing in practice: Increments of time and capacity on Amazon

The screenshot shows the Amazon Web Services Simple Monthly Calculator interface. It includes input fields for various usage metrics and a summary table of costs.

Category	Item	Value	Unit
Usage	High-CPU Extra Large Windows with Authentication Services and SQL Server Standard Instance Compute Usage:	1	Instance Hours
	Data Transfer-in:	1	GB
	Data Transfer-out:	1	GB
	EBS Storage (Volumes):	1	GB-months
	EBS I/O Requests:	1	Million Requests
	EBS Snapshots Storage:	0	GB-months
	EBS Snapshots GET Requests:	0	Requests
EBS Snapshots PUT Requests:	0	Requests	
Amazon EC2	Compute	\$ 3.20	
	Data Transfer	\$ 0.27	
	EBS Volumes	\$ 0.20	
	EBS Snapshots	\$ 0.00	
	Amazon EC2 Bill:	\$ 3.67	

Amazon charges for running a large instance of Windows and SQL server for a single hour (for \$3.20) plus related charges for I/O and storage

Source: Amazon

Licensing increments of capacity

The emerging infrastructure will enable customers to provision additional capacity by adjusting the size of, moving, or adding virtual machines for discrete increments of capacity, such as a single processor core, from their total license capacity. By contrast, **licenses are “fused” to a physical box today and are difficult to move to another box.** As capacity management becomes as trivial as moving a running database VM to more processors or even a bigger box, customers will be able to buy less capacity up front. In other words, the very same virtualization technology that radically improves server hardware utilization through consolidation can be applied to improve server software utilization.

Licensing increments of time

In an on-demand world, customers are likely to go further than just licensing incremental capacity. They are likely to force server software vendors to recognize that licenses are not associated with servers in perpetuity. That means vendors will have to accommodate, not just capacity, but time in their licenses.

As a result, licenses will likely have to change from perpetual to a more subscription-oriented X amount of capacity for Y amount of time. When a customer can add capacity by moving a database VM to a bigger machine for a temporary spike in demand, whether for several hours or several weeks, customers need the flexibility to pay for increments of both time and capacity. As vendors provide auditing tools, customers will be able to subscribe to units of capacity for discrete amounts of time each quarter.

A move to a subscription pricing model would be highly disruptive to current business models. Having up-front recognition of perpetual licenses give way to subscriptions would have a material impact on recognized revenues and reported earnings. Even if vendors were able to bill 1 or 2 years up front, the cash flow and non GAAP earnings would still not make up the difference. It would probably require 4 to 6 years up-front billings to duplicate the cash equivalent of perpetual licenses.

Key controversies

Isn't the market experiencing strong consolidation around these three primary vendors, giving them greater pricing power?

There is no question the market is experiencing consolidation and, as a result, these vendors have more pricing power than IT services vendors, for example. That bargaining power only postpones the inevitable. It does not exclude it. Both IBM and Microsoft have already embraced some level of virtualization-friendly, variable-capacity pricing within the enterprise and that will exert increasing pressure on Oracle.

Market dynamics

Market overview

Oracle as a company is the single vendor most sensitive to the risks of virtualization because of its greater relative exposure to capacity on-demand pricing.

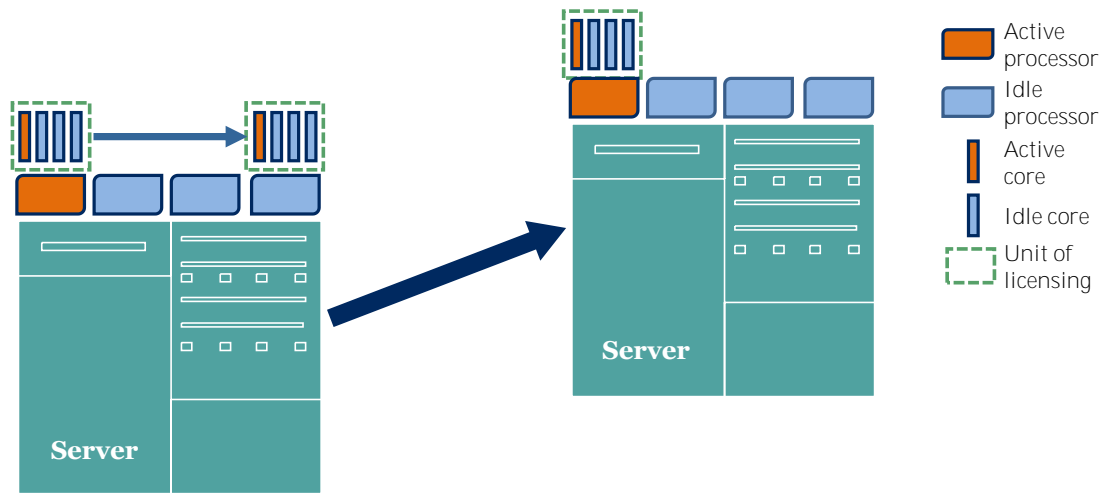
Database and middleware license and maintenance revenue account for an estimated 60% of total revenue. The maintenance estimate was based on the portion of overall license revenue from database and middleware technology. Two leading indicators of its ability to hold out are its pricing on its own hypervisor and on Amazon Web Services. The User Scenarios below elaborate on this.

User scenarios

In September 2008, Microsoft introduced new, virtualization-friendly licensing for its server applications. While not going as far as per-hour charges on Amazon, the new model allows for licenses to move not only across processor cores in a server, but also between servers themselves.

This allows customers to create an HA/DR setup or manage planned downtime without having to license every core on every processor on every server the application might touch. In other words, customers only have to license either the maximum number of instances or the maximum number of cores that they will need.

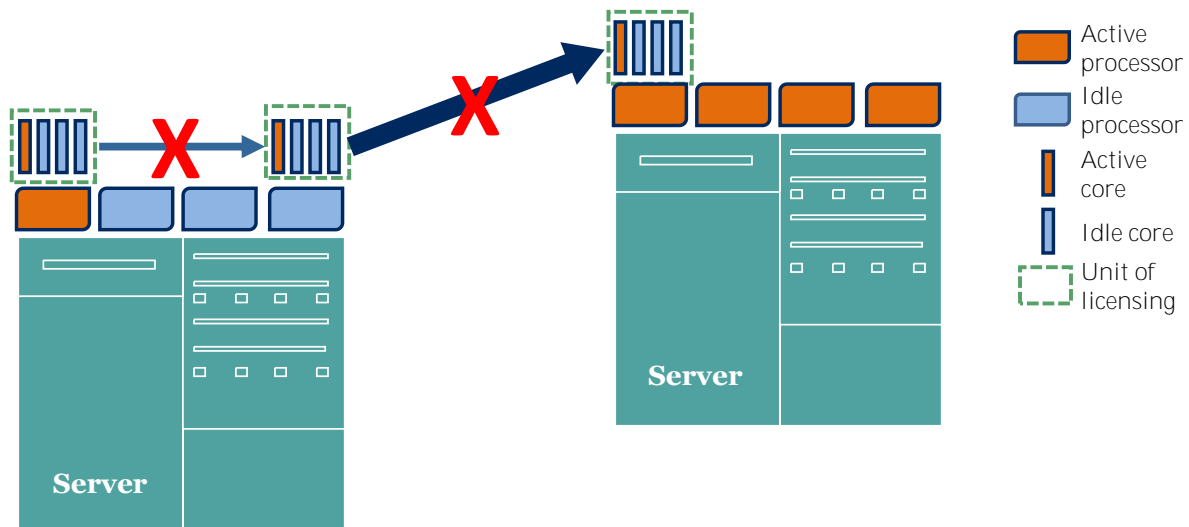
Microsoft server application virtualization license mobility



- **With Microsoft's** license mobility announced in September, SQL Server or other applications can move to another processor or even another server in a different cluster in a different data center no more than 5 time zones away, without triggering extra charges
- Host OS is generally Windows **Server Data Center Edition**, guest OS's can be either **Standard**, **Enterprise**, or **Data Center Edition**

Source: TechAlpha analysis

Oracle DBMS/middleware server application virtualization license mobility



- The key difference from Microsoft is that Oracle requires the customer to physically bind the database in the VM partition (or other hard partition) to specific physical processor cores without allowing for movement
- To accommodate failover for planned or unplanned maintenance, Oracle only allows 10 individual days per year on a different server, whereas Microsoft allows unlimited mobility. This means that having a DR site either in standby or active mode requires a fully licensed configuration, i.e., customers pay twice

Source: TechAlpha analysis

Business benefits

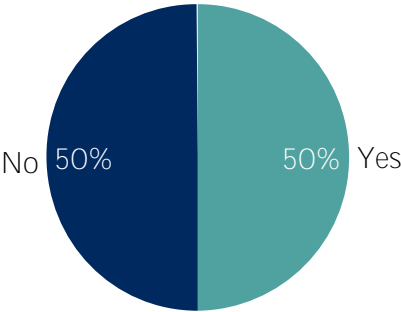
Capital requirements for start-ups for physical infrastructure have collapsed as a result of capacity on demand from cloud providers such as Amazon. The same capital efficiency is likely to come to server software, to the benefit of customers of all sizes and at the expense of vendors.

Market size and growth

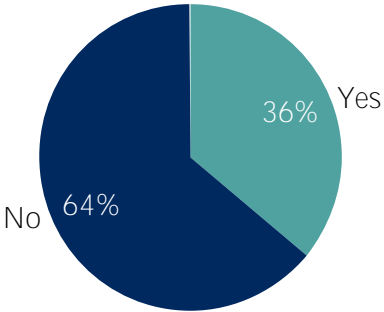
Full backing of virtualization becomes a must-have for server software vendors

Will you be buying less from certain server software vendors in 2010 if their pricing model or technical support does not adequately embrace virtualization by then?

Respondents >20 servers
n = 62



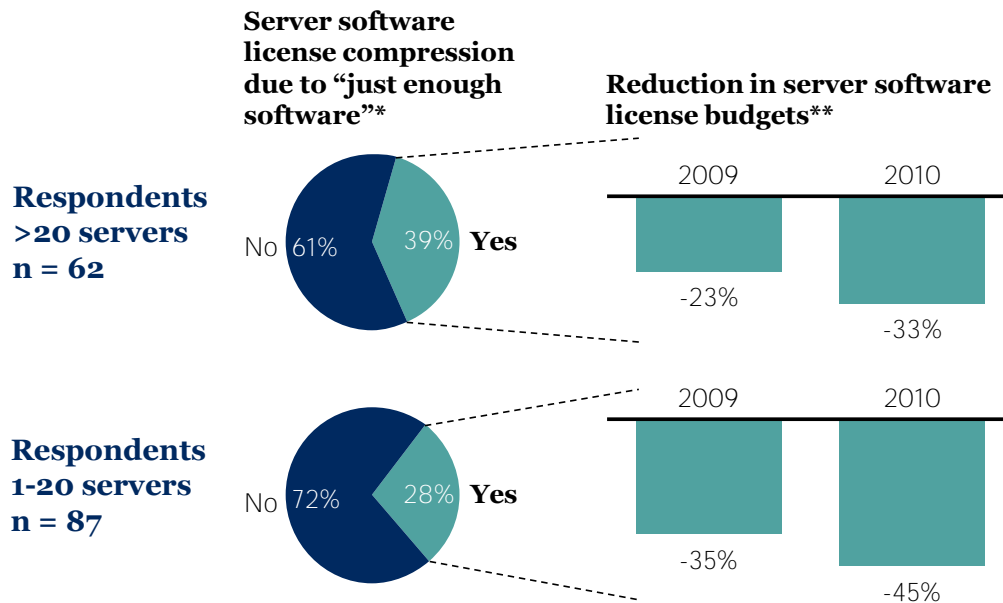
Respondents 1-20 servers
n = 87



Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

As customers become aware of the mismatch between license capacity and consumption, they become more insistent on a more favorable resolution. Fully 50% of those who were mid-size and above said they would buy less software from vendors who did not embrace virtualization, either with technical support or pricing. Thus far, Oracle is the largest ISV that has not announced technical support or pricing for VMware environments.

Impact of “just in time” capacity allocation on server software purchases is substantial



* Do you expect to purchase fewer server software licenses (e.g., databases, middleware, operating systems) in 2009 or 2010 because instant provisioning and load balancing enable “just in time” capacity allocation instead of “just in case”?

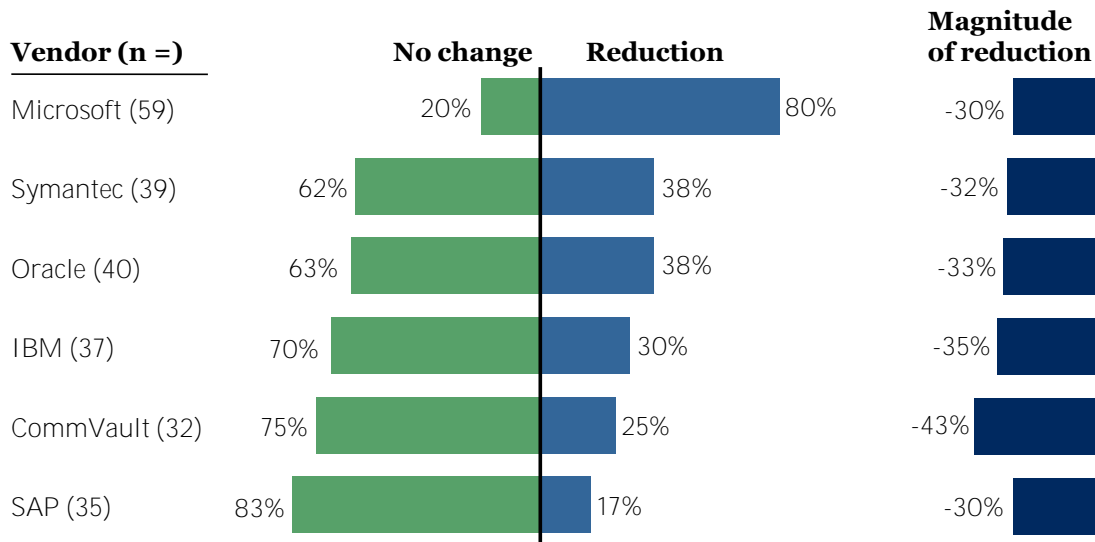
** If you answered Yes to the previous question, what percentage reduction do you expect in the number of server software licenses bought in...?

Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

In our survey of customers of all sizes we found consistent and material plans to shrink server software purchase plans within the next 24 months. Of the mid-size and above customers, with more than 20 servers, 39% planned to purchase less software over the next 2 years. By 2010 those 39% expected to buy 33% less software because of the **ability to buy “just in time” instead of “just in case.”** While it may be misleading to project an Oracle P&L off these numbers, the broader point is that a growing number of customers are becoming aware of the license capacity mismatch and have concrete plans to deal with it.

Survey respondents see Microsoft, Symantec and Oracle spend most at risk

If you answered Yes to the previous question, which vendors will you be spending less with, again in the server software spend category? How much less, not considering across-the-board budget cuts due to the state of the economy?



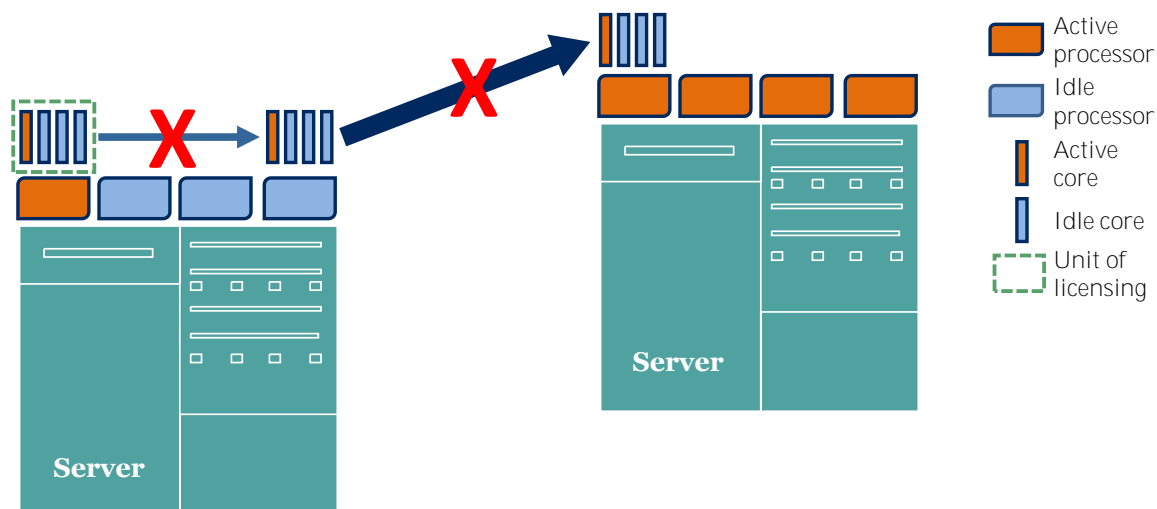
Source: TechAlpha online survey of US IT executives conducted November 10-30, 2008

Of those who planned to purchase less software, customers were asked which vendors it would affect. While 80% said Microsoft, that number is likely skewed by the greater number of smaller customers. However, across all vendors, the magnitude of the reduction was surprisingly consistent at around 30-35%.

SWOT for ORCL

Oracle is by far the largest ISV that does not provide technical support for VMware environments. It does support its own hypervisor, Oracle VM. However, vendors and customers should watch how Oracle pricing evolves on its own VM and how it accommodates allocating a server license to a bigger machine or a bigger part of an existing machine. Today, even with its own VM, customers must bind the server software to physically distinct processor cores. Their licensing explicitly prohibits the use of “soft partitioning,” where the resource manager (like a virtual machine) limits access to the number of cores.

Oracle DBMS/middleware server application virtualization license mobility



- The key difference from Microsoft is that Oracle requires the customer to physically bind the database in the VM partition (or other hard partition) to specific physical processor cores without allowing for movement
- To accommodate failover for planned or unplanned maintenance, Oracle only allows 10 individual days per year on a different server, a much more restrictive practice than Microsoft. This means having a DR site either in standby or active mode requires a fully licensed configuration, i.e., customers pay twice

Source: TechAlpha analysis

The other leading indicator to watch is Oracle’s support for Amazon. Oracle cannot watch every Web startup in the world show how they are using MySQL on Amazon. Today, Oracle’s licensing terms on Amazon Web Services make no provision for either incremental use of capacity or use of capacity for a defined set of time. If a vendor’s application experiences a spike in demand from 4 to 4,000 servers when everyone floods the Web site one day, the vendor will have to have a license in advance for all 4,000 servers in perpetuity.

SWOT for MSFT

Microsoft is in the unique position for now of having the dominant deployment platform in Windows Server and a broad portfolio of high-volume server applications. Since Windows Server is used in roughly 80% of x86 virtualization deployments, Microsoft has been able to require customers to use a premium SKU, Data Center Edition, as the host or parent partition. That is driving a mix shift toward higher price points for all Windows Server shipments.

On the server applications side, they are accommodating virtualization as shown in the figure in User Scenarios above. We believe that what revenue they might give up in better accommodating on-demand will be somewhat balanced out against the premium Windows SKU.

SWOT for IBM

IBM has already adjusted its server software licensing to accommodate virtualization environments. To some extent they already faced this pricing model before with mainframe and AIX partitions. While less forward capacity buying may have an impact on IBM, server software is not a big enough share of their total revenue to have the same impact as Oracle.

VIII. Spotlight on VMware

While we expect VMware to regain some of its commercial momentum in server virtualization in 2009, we expect VMware's **strategy will emphasize investments in** desktop virtualization since Microsoft will be conflicted to drive innovation in that area.

During the course of 2008, VMware forward sold a lot of functionality using ELAs (enterprise license agreements), even beyond their vanilla server consolidation, hoping **to accelerate customer adoption ahead of Microsoft's delivery of entry-level server consolidation functionality.**

The biggest near-term driver of their performance will be the pace at which customers can absorb and deploy VMware's **second wave of functionality, which is focused on** business continuity and disaster recovery. However, the ROI on business continuity is softer than consolidation and there are now two buyers in the sales process, the application owner in addition to the infrastructure owner. So the uptake rate for this second wave of functionality is likely to be measurably slower, also reinforced by the inventory overhang brought on by forward selling.

Adding yet another layer of functionality, data center management and automation, will, if successful, dramatically expand the total addressable market but require a C-level sell and a greater level of competition with Microsoft and the Big 4 systems management vendors. VMware is likely to experience a greater level of competitive intensity from Microsoft in this category relative to the two prior categories as Microsoft has considerably more technical and channel assets to bring to bear.

Potential strategy shift appears on the horizon.

We believe VMware's original vision was that virtualization was a fundamental **discontinuity in managing the datacenter. Customers would deploy the company's** infrastructure and management tools end-to-end across all their servers.

In an analyst breakout at the VMworld trade show in September 2008, one VP said VMware expected customers ultimately to virtualize all their servers, even the ones that **wouldn't benefit from consolidation. In that example, uniformly delivering high** availability across all tiers in an application would require end-to-end virtualization. On the show floor, the company explained the benefits of providing more generalized end-to-end management of application services.

It appears VMware's new CEO Paul Maritz questioned several key assumptions behind **the previous vision and started indicating a shift in direction at this fall's VMworld** trade-show.

In a separate session, Maritz indicated a willingness to depart from the original more homogeneous VMware-only view. Specifically, he left open the **possibility of supporting other vendors' hypervisors** with VMware management tools at some point in the future.

Maritz also made it clear that VMware had to manage its own platform since customers always demand that of a platform provider. But he emphasized that VMware would plug into broader management platforms, presumably from Microsoft and the big 4. The emphasis of his remarks was that **VMware was adding management value to its platform because it was a natural follow-on, not because it was a disruptive technology** and planned to overthrow the status quo in systems management.

Subsequent interviews with industry CTOs suggested that while virtualization was a disruptive enabler for managing infrastructure, **service-orientation was the key technology** that would enable next generation application management. In other words, VMware was not necessarily disrupting the technical assets in development and deployment from Microsoft and the big 4.

At about the same time that Maritz made these statements, **the EVP of R&D, Richard Sarwal, returned to Oracle after only 9 months** on the job. At Oracle he was and returned as SVP of development for systems management. VMware acknowledged that he differed with Maritz's choice of direction for the company.

Finally, Maritz announced that within the constraints of the slower hiring pace, **70% of new headcount was going to the desktop virtualization** initiative. More cryptically, he said that competing with Microsoft required shifting toward a direction they would be **conflicted in following**. **Although the details of VMware's likely user and information-centric strategy are not yet clear, we believe they view that as a more sustainable strategy where the operating system is not as central to the user's experience.**

IX. Implications for Other Sectors

Other areas, some of which will be covered in future reports, will also be impacted.

Security Software

Another area that might see disruption in Wave 3 is application and data security (antivirus, spyware, threat detection, firewall, configuration, and patch management, etc.). Currently, VMware focuses on maintaining the security of the virtual machine container. It is now moving into ensuring configuration and patch management inside the VM. While we would expect it to partner with the leading application and data security vendors, it is quite conceivable that VMware will become a major channel and choke point for application and data security vendors.

Security technology is increasingly based on behavioral approaches. Signature-based approaches do not work that well, because malware is growing exponentially. With hypervisors though, you cannot really examine large chunks of memory or examine calls because the performance tax would be too great.

IT Services

We see great disruption to the IT services business based on the automation which virtualization enables.

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