IT Audit

EMC's Journey to the Private Cloud

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Contents

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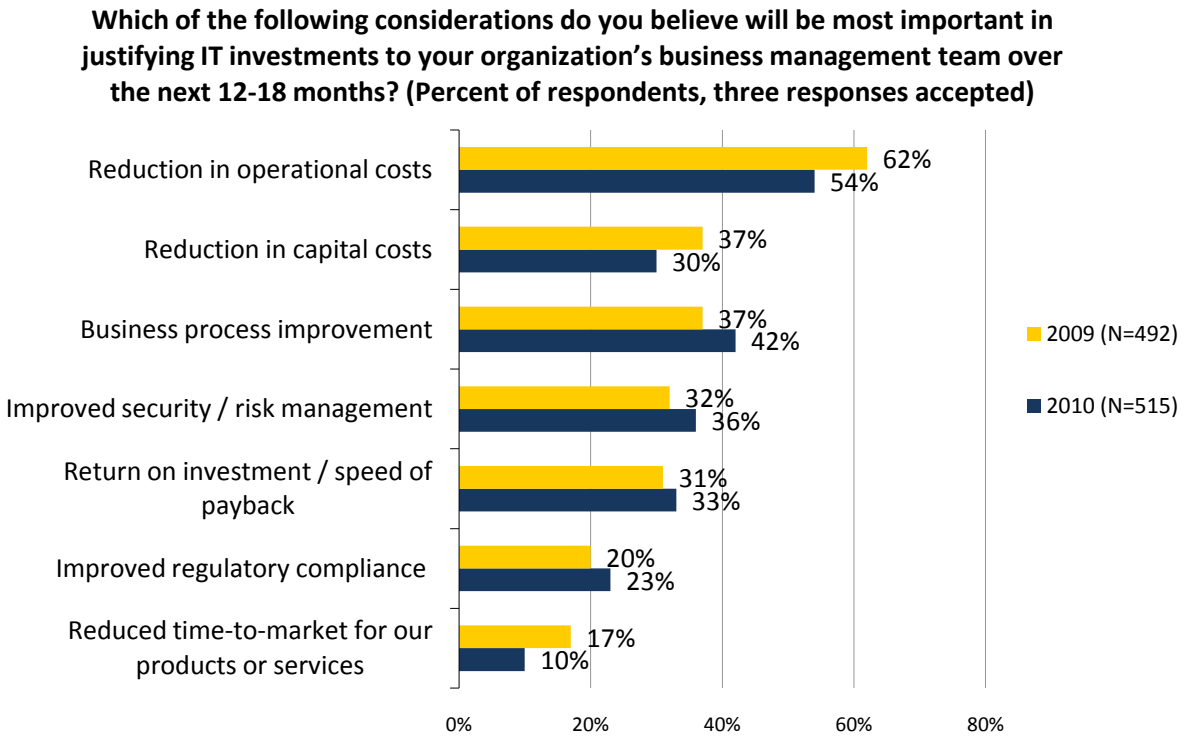
Introducing the Journey

EMC started on a journey to the cloud ten years ago, long before the term "cloud" became popular, laying the foundation for more focused efforts that began in 2004. In April 2009, ESG published an initial audit of EMC's achievements, which were impressive: $74 million in data center equipment savings, $12+ million in power and space savings, and dramatic increases in productivity, efficiency, and resource utilization. This update examines EMC's efforts over the past year, and reveals an acceleration of savings and a launch pad for further success.

In 2004, EMC faced challenges familiar to most IT organizations: unrelenting growth of applications, servers, and storage arrays in the data center that strained the capacity of existing resources. The projected cost of a new, energy-efficient data center was extremely high, about $120 million. Senior management asked EMC IT to follow the advice that EMC gives its own customers: investigate whether greater efficiency would allow them to "do more with less" and squeeze additional life out of the current resources. Subsequent analysis revealed that by reducing costs, increasing efficiency, and improving business processes, EMC could avoid that costly data center expansion and instead extend the useful life of its 30-year-old Westborough, Massachusetts data center.

EMC's priorities are no different from other organizations—as ESG's 2010 IT spending survey reveals, reducing capital and operational costs, as well as improving business processes, remain top priorities for most companies. However, cost is not the only consideration this year; they also expect to increase focus on security, return on investment, and compliance over the next 12-18 months.[1]

Figure 1. Most Important Considerations for Justifying 2010 IT Investments, 2009 vs. 2010



Source: Enterprise Strategy Group, 2010.

A Three Phase Journey to the Private Cloud

Faced with the diminishing returns of monolithic, application-specific solutions (including application-dedicated servers, direct-attached storage and point management solutions), EMC's three-phase journey to the private cloud began back in 2004.

[1] Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.

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Phase 1: IT Production. Reducing IT costs was the primary goal of this first phase of the journey. This phase focused on consolidating and virtualizing the IT infrastructure including servers, storage, networks, and desktops. Consolidation and automation were used to increase efficiency and reduce costs. Data center optimization was also a key part of this phase; consolidation and virtualization deliver more efficient power and cooling as well as better utilization rates for storage and servers. Server and storage tiering was used to focus high-level resources where needed and reduce costs where possible.

Phase 2: Business Production. The goal during this phase is to improve the quality of services for business units and end-users. EMC began delivering application services from a virtualized infrastructure, meeting business level SLAs for production applications.

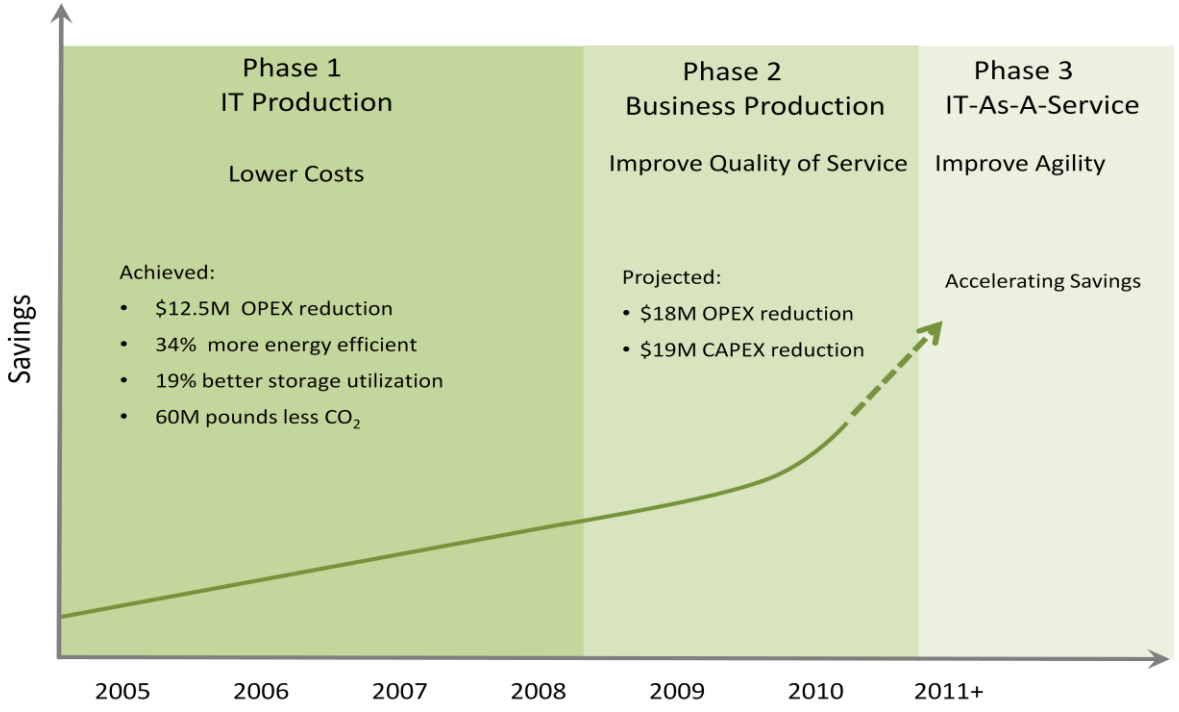
Phase 3: IT as a Service. Improving the agility of the IT organization is the goal during this phase. Automation, federation, and self-service provisioning are key initiatives. Where it makes sense, secure external cloud services are being used to react quicker to the needs of the business. Current examples include salesforce.com and the delivery of product demonstrations via infrastructure as a service. Proper monitoring and governance are required to ensure that service levels and corporate policies regarding risk, compliance, etc. are met.

A CIO's Perspective

"EMC's journey to the cloud began back in 2004 before cloud computing was cool" , said Sanjay Mirchandani, CIO, EMC. "Based on the solid foundation that was put into place during the first phase, we're moving quicker into the next phase and the savings are accelerating."

At this juncture, it is clear that the journey through each phase is accelerating (see Figure 2). As EMC proceeds through Phase 2, savings and efficiency not only have increased, but gained momentum and velocity—bringing EMC value for its investment at a faster rate. The foundation delivered in Phase 1 (server virtualization, storage optimization, and IT efficiency) achieved significant objectives, including $12.5 million in cost savings, 34% more energy efficiency, 19% better storage utilization, and a reduction of CO2 emissions by 60 million pounds. Leveraging both private and external clouds in Phase 2, EMC is projecting even greater cost savings and cost avoidance. As it continues to build on this efficient foundation and approach 100% virtualization, savings are accelerating.

Figure 2. Accelerating Savings



Source: Enterprise Strategy Group, 2010.

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Cloud Initiatives

Let's take a closer look at Phase 1 of EMC's journey.[2]

Server Virtualization. In the first phase of VMware server virtualization, older servers consuming two units of rack space were replaced with larger, more efficient servers consuming four units of rack space. Two tiers of virtual server infrastructure were defined. Tier 1 offered high availability and disaster recovery for critical applications; of the approximately 400 applications supported by EMC's worldwide IT organization, this tier served about 20 mission critical applications (increasing to 27 at the end of each fiscal quarter to support peak needs). Tier 2, offering high availability only, was designed for the majority of applications that can tolerate the delay of a restore after a disaster.

In Phase 1, EMC used the first two of four server efficiency tactics:

- Tactic 1: Virtualize new dedicated application environments. Instead of buying 15-20 physical servers to support a given application project, EMC was able to buy just 3-4 and load multiple virtual machines on each to support production and non-production environments.
- Tactic 2: Replace "end of service life" (EOSL) hardware with virtualized, shared servers. Instead of buying replacement servers for every EOSL server, EMC built out its VMware ESX servers, virtualized the application environments, and decommissioned many of the physical servers that had been in use.

Optimized Storage for Virtualized Environments. When EMC's IT efficiency efforts began, the majority of online IT assets resided on high-end EMC Symmetrix storage arrays (tier-1), with the balance on modular EMC CLARiiON arrays (tier-2). To reduce costs and extend the life of the existing data centers, EMC expanded their tiered structure. More cost-effective, large-capacity drives within Symmetrix and CLARiiON storage arrays were introduced over time to create online storage tiers 3 and 4, and tier-5 CLARiiON Disk Library (CDL) capacity was added for disk-based backups. Moving to a tiered storage infrastructure has dramatically reduced the power consumption—and cost—of delivering information services at EMC.

EMC professional services and a wide variety of EMC software products were used to increase the efficiency of the tiered storage infrastructure. E-mail archiving is a notable example. SourceOne was used to move e-mails to a more cost-effective storage tier over time. This also expanded the size of end-users' mailboxes, which improved productivity, centralized management, and made it easier to respond to legal and regulatory discovery requests.

Data Center Optimization. As much as half of the electricity purchased from a utility company can be lost due to inefficient power and cooling systems in the data center. As a result, optimizing the delivery of data center power and cool air can lead to significant savings. EMC created a multi-year strategy to increase space and energy efficiency, as well as operational effectiveness, in its existing data centers. Significant efficiency gains have been realized from data center cooling and airflow improvements, including:

- Hot and cold aisles designed to eliminate hot spots
- Hot air return plenum for more efficient removal of heated air
- More efficient Computer Room Air Conditioning (CRAC) units
- Filler panels over rack units with no equipment installed
- Floor "pillows" to reduce wasted air flow around cables
- Selective in-row cooling
- Ultrasonic humidification
- Monthly CFD analysis to identify and rectify hot spots with vented floor tiles

EMC's Green Journey

This report not only provides a blueprint for savings and efficiency, it also illustrates how EMC has seized the opportunity to act on the global environmental challenges of climate change, energy consumption, and material waste. Our calculations indicate that the combined effect of the consolidation and efficiency initiatives that have formed the foundation for EMC's journey to the cloud will reduce emissions by 90 million pounds of carbon dioxide over the next five years. That's the equivalent of planting 1.9 million trees or taking 9,000 cars off the road.

[2] For additional detail, see ESG Lab Audit Report, *EMC IT -- a Blueprint for Data Center Efficiency*, April 2009.

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Progress Report

Key Findings as of 2009

When ESG reviewed EMC's server, storage, and data center efficiency efforts in 2009, it was clear that EMC had developed a practical blueprint for improving efficiency, effectiveness, and environmental sustainability through existing technologies and best practices. Among the keys to success we identified were a strategic vision, sound business planning processes, executive-level buy-in, and access to EMC's own professional services engagements.

Extending the tiered storage infrastructure dramatically reduced the power consumption (and cost) of delivering information services, with savings increasing once archiving on tiers 3 and 4 really took hold. In addition, savings were generated from automated e-mail archiving and implementing a mix of disk and tape backup. Equally important, the consolidated storage environment increased the operational efficiency of IT staff by 170%.

By 2009, the server consolidation effort had resulted in consolidating 1,250 servers down to only 250 while consuming 60% less space, 70% less power, and 70% less cooling. These results came from the first two server virtualization tactics. Tactic 1 (virtualizing new, dedicated application environments) helped EMC to avoid buying 640 physical servers through December 2008. CPU utilization was not optimized, with the P2V consolidation ratio remaining at only 5:1, because servers were still dedicated to specific applications. Tactic 2 (replacing EOSL hardware with shared, virtualized servers) enabled EMC to decommission 424 physical servers and replace them with only 62 virtualized servers. The consolidation ratio of tactics 1 and 2 was 7:1—a significant improvement, but not yet to the level that EMC wanted for optimal CPU utilization.

Progress Since 2009

Server virtualization: In the past year, EMC has continued to achieve the savings that were already underway. In addition, new initiatives have begun, starting with server virtualization Tactics 3 and 4, which EMC calls "hyper consolidation."

- Tactic 3: The EMC IT organization has architected and deployed a consolidated, virtual, tiered, shared application platform. All new applications or infrastructure moving into the data center are now being hosted on virtual machines. This new virtual server infrastructure is based on VMware vSphere and a full suite of VMware products, with five tiers of EMC SAN and NAS storage. This effort is designed to achieve 40:1 consolidation ratios and optimal CPU utilization; based on annual demand projections over the next five years, EMC expects to avoid the purchase of 750 servers.
- Tactic 4: The EMC IT organization has embraced a "sweep the floor" initiative, which it hopes to complete in 2010. This effort includes migrating applications currently running on 1,600 servers to 1,600 VMs running on 40 servers. EMC expects to save $13 million in cost avoidance and an additional $10 million in cost savings over the next five years, as well as dramatically reducing its carbon footprint and improving CPU and memory utilization rates. These efforts will enable EMC to host new applications on demand, providing faster service when users need infrastructure.

Storage Optimization: Storage optimization efforts continued in 2009 with a goal of continuous improvement in the levels of consolidation and savings that can be achieved. New disk arrays with higher densities and multiple tiers of storage were used to consolidate onto fewer, more cost-effective, disk arrays. FAST technology was adopted to automate the movement of information between tiers of storage for optimal performance and cost efficiency. Enterprise Flash Drives (EFD) were tested with performance sensitive Oracle and SQL database applications. The migration from tape to disk continued as tape libraries were decommissioned and disk-based backup solutions were deployed. Data deduplication was deployed to increase the efficiency of EMC's growing backup-to-disk policy.

Desktop Virtualization: EMC has begun a virtual desktop infrastructure (VDI) pilot project (using VMware View) with the goal of 100% virtualized desktops by 2012. At this point, the first 600 users worldwide are using virtualized desktops. EMC expects to gain from lower device costs and extended client device lifecycles, as well as better

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corporate security across the desktop infrastructure. Equally important, it will improve the user experience for EMC employees around the world. The plan is to use tier-1 SANs for desktop boot data, but use NAS for user data to keep costs down. Since enterprise-scale VDI must support thousands of concurrent users, EMC plans to use vBlocks, the bundled, pre-integrated infrastructure units that include Cisco Unified Computing Systems (UCS), VMware vSphere, and EMC Unified Storage.

Looking to the Future

Various additional initiatives and efforts are underway as the future unfolds and EMC continues on its efficiency and cost reduction path.

- *The "Virtual First" Initiative.* Unless there is a compelling reason against it, all new applications are deployed on a virtual infrastructure. This aggressive strategy is designed to stop the physical server sprawl.
- *Advanced Storage Tiering.* Having seen the benefits of expanded storage tiers, EMC will continue to implement a tiered/shared model. The plan is to automate data movement between tiers and selectively use solid-state disk for applications that require high performance. Dense, affordable SATA disk will continue to be the standard otherwise. EMC plans to implement Fully Automated Storage Tiering (FAST) for automated, policy-based data movement, which will help streamline storage costs and maximize resource utilization. By using Symmetrix V-Max storage and PowerPath Virtual Edition on VMware vSphere clusters with FAST, EMC expects to increase the storage utilization rate from 68% to 80% and avoid the purchase of more than 1.5 petabytes of storage over five years.
- *VMware Site Recovery Manager (SRM).* An upgrade to VMware vSphere and the use of SRM for automated failover of virtual machines are part of the plan. Automation of DR offers clear management advantages, while leveraging VMware's private cloud operating environment will help in deploying distributed IT services.
- *Cisco Nexus 5000 Series Switches.* EMC is also developing a plan with Cisco to introduce converged network adapters and Nexus 5000 Series switches. EMC expects to gain cost and efficiency benefits such as a 15:3 cable reduction on VMware ESX servers.
- *Ionix Server Configuration Manager (SCM).* EMC's infrastructure will continue to grow, just more efficiently now that the company has its eye on the ball. Implementing EMC Ionix SCM will simplify the cumbersome configuration and change management processes across physical and virtual servers, as well as monitoring and alerting IT to resolve problems and ensure compliance. Automation with Ionix SCM can be extremely effective in reducing costs, ensuring security and compliance, and minimizing low-level IT tasks.
- *Virtual Desktops.* EMC plans to have 100% virtualized desktops by 2012, resulting in improved and simplified security, lower client TCO, rapid deployment, reduced support costs, and user-based provisioning.
- *RSA DLP and Encryption.* EMC plans to enable further security for virtual machines using RSA data loss prevention (DLP) and encryption technologies. RSA and VMware have been working together to integrate security into VMware View environments; the tight integration of these EMC entities can only add value.[3]
- *Greenfield Data Center.* EMC began an exciting project since ESG's April 2009 audit: a new data center is being designed in Research Triangle Park (RTP), North Carolina. While EMC's previous efforts were focused on extending the life of an existing data center, EMC has a clean slate in RTP to build a new, "green efficient" data center. Opportunities in this new data center may include the consolidation benefits of Fibre Channel over Ethernet, consolidating infrastructure onto fewer wires using network convergence, and deploying vBlock for selected applications.

[3] For more, see ESG White Paper, *Desktop Virtualization, Management and Security*, November 2009.

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Lessons Learned

EMC has learned a number of important lessons during this process. First, the importance of executive sponsorship of a project such as this cannot be overstated. These changes require a dramatic shift in strategy and daily operations that can only be successful if fully supported by management and woven into business processes.

- *Server Consolidation Ratios.* As mentioned previously, early server virtualization efforts often result in hefty consolidation ratios. It is easy to see opportunities in utility servers such as print and Active Directory, for example. Later on, server virtualization efforts may not achieve the same consolidation rates, in part because mission-critical applications tend to have greater resource requirements. But the benefits remain; even if consolidation rates are not as high, the equipment and management costs are significant.
- *Risk Mitigation.* Corporate governance and process will be impacted in these efforts and must be planned for. Critical examples are security and risk. A frivolous entry into the cloud without upfront planning will result in vulnerabilities that could be devastating. Every step of your journey through private, external, and public cloud initiatives must have security baked in—otherwise, your entire organization is at risk.
- *Monitoring and Logging.* As applications are deployed—and moved—within a virtual infrastructure, centralized logging and auditing managed by EMC is vitally needed to ensure the security and stability of IT service delivery. As EMC's network grows to connect with partners developing products and external cloud providers providing outsourced service delivery, EMC must have access to networking and security logs. Outsourcing this vital function would put EMC at risk.
- *Organizational Impact.* EMC's journey has demonstrated that it is easier to change technology than behavior. You may implement a new technology and change the way IT infrastructure is deployed fairly quickly, but you must understand the impact on the organization and the transformation that will ensue. These are not trivial issues. It is important to understand the strengths and organizational structure of your current team, because cloud-based IT tends to blur organizational lines. For example, vSphere enables you to manage your virtual servers fairly deeply into your storage and networking infrastructures. Do your server and network staff now need to know more about storage? Will they find this need for new skills exciting or threatening? How easy will it be to morph the current organizational structure into one that is effective for the new technology structure? Don't expect these changes to take care of themselves—they won't, and ignoring them could threaten the improvements you are trying to make.
- *User Choice and Control.* Similarly, project and process management are impacted by this type of effort. For example, departments may find it easy to buy public cloud infrastructure services on a corporate credit card for some projects. While this may be part of your plan, it must be managed by IT. Otherwise, users can circumvent IT's oversight of service-level, corporate policy, and compliance requirements. IT should participate in the approval and procurement processes to ensure the corporate good.
- *Demand.* The ease of acquiring cloud infrastructure services can make end-users feel that resources are unlimited. Without implementing chargeback mechanisms, it can be difficult to slow the acquisition process. At the same time, while chargeback can make departments more responsible, it may not be worthwhile to implement this additional tracking and accounting process.

  Service Bureau. These new technologies may change the nature of IT for some. IT could act as a kind of service bureau, deciding which projects to do in-house, which to outsource to a partner, which to deploy from a secure private cloud, and which to offload to an external cloud. By participating in this way, IT can ensure adequate performance, reliability, affordability, and compliance.
- *Information Technology Infrastructure Library (ITIL).* As processes are defined and automated to take advantage of cloud-based services, IT best-practices that fit the needs of the business must be defined. Tools like the EMC Ionix IT Services Management Suite have been used to automate those ITIL-based processes.

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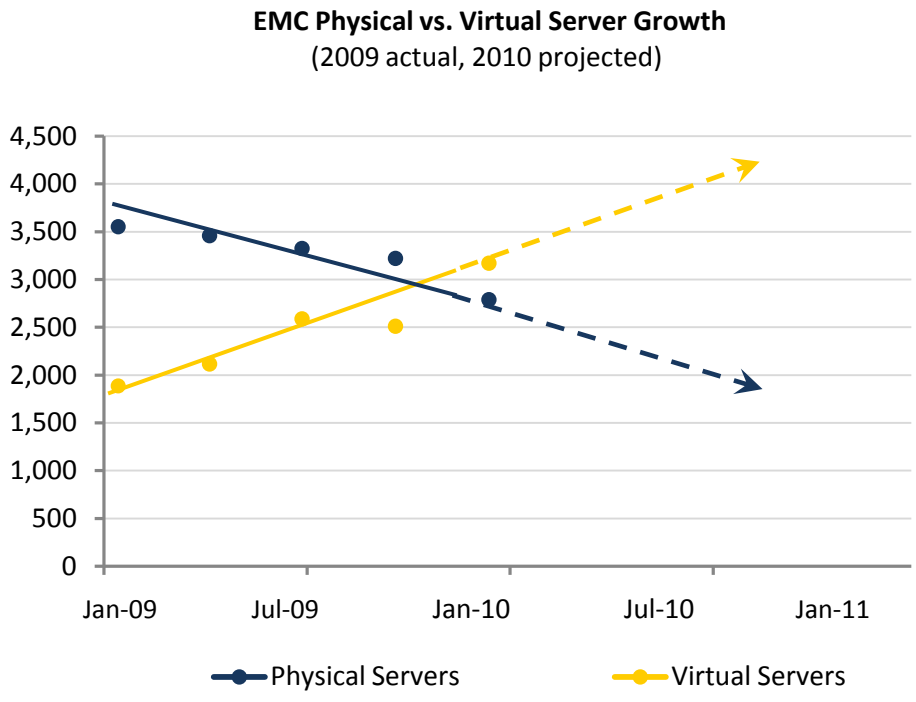
- *Information Governance.* Documented processes that define how information is controlled, accessed, and used are needed more than ever in a cloud environment. An executive-sponsored framework is recommended to take information governance into the cloud.
- *Project Management.* Finally, change control, project management, and program management are equally important. With today's standard IT silos, storage initiatives are managed, tracked, and reported on by the storage director; server initiatives are managed, tracked, and reported on by the systems director; and so on. As the lines blur, who is responsible for cloud initiatives? Who owns that budget and is responsible for keeping it on track? Does the security organization have the information and controls in place to ensure that applications and end users are not put at risk? These are important considerations that should be established at the beginning of the process.

The Bottom Line

EMC's journey to the cloud yielded a number of substantial cost reduction and efficiency benefits between Jan 1, 2008 and Jan 1, 2010. The server virtualization and consolidation initiative—which was especially active in 2009—is a good place to begin with as we examine the benefits that were achieved as the second phase of the journey began.

As shown in Figure 3, EMC passed the crossover point in terms of physical versus virtual servers towards the end of 2009. Until recently, more physical servers were in use, but now EMC has more virtual servers. As might be expected, initial virtualization efforts focused on utility-type applications—considered "low hanging fruit"—while today more mission-critical workloads are targeted. Application and business requirements continue to change while these efficiency efforts are in process; with so many moving parts and the "low hanging fruit" already picked, EMC is unlikely to continue doubling the consolidation rate.

Figure 3. 2009: The Crossover Point for Physical/Virtual Servers In EMC's IT Organization



Source: Enterprise Strategy Group, 2010.

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Highlights of EMC's journey to the cloud server virtualization initiative in 2009 include:

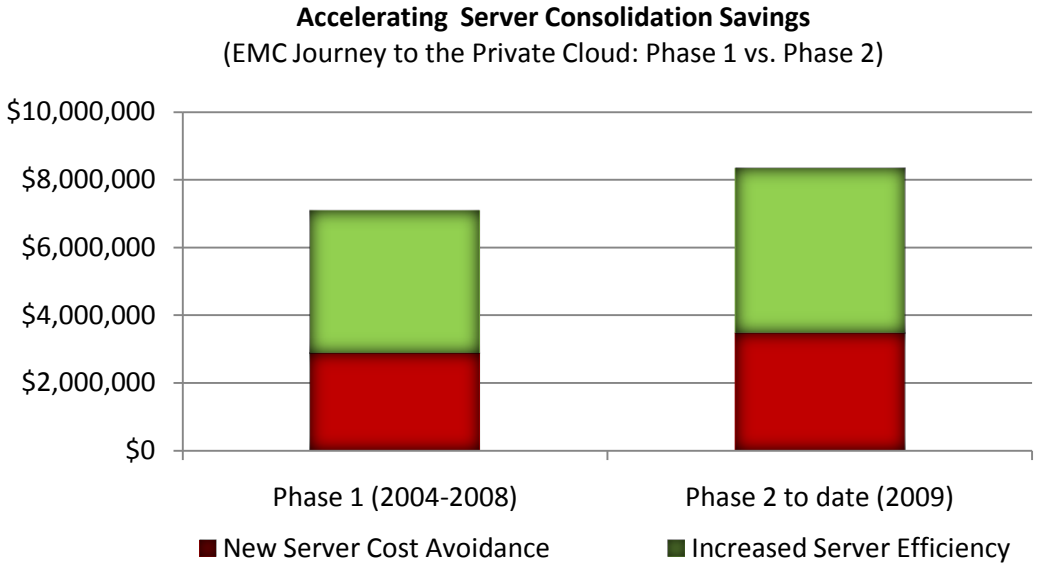
- Decreasing the number of physical servers by 764.
- Increasing the number of virtual servers by 1,284.
- Adding 520 new virtualized application servers.

EMC's server virtualization and consolidation efforts in 2009 resulted in significant savings:

- $3.5M in power, cooling, and data center space savings are projected over the next five years.
- $4.8M in server capital equipment costs were avoided.

While the dollar amounts are significant, what's more impressive is the fact that the rate of savings is accelerating compared to the first wave of consolidation.

Figure 4. Physical to Virtual Server Migration Savings Accelerated in 2009



Source: Enterprise Strategy Group, 2009.

EMC realized a number of significant benefits in 2009 as Phase 2 of the journey got under way:

- Ongoing server virtualization and consolidation efforts avoided $4.8 million in server capital equipment costs resulting in an estimated savings of $3.5 million for power, cooling, and data center space over the next five years.
- Ongoing storage efficiency and reclamation efforts reduced allocated storage capacity by 400 TB as storage utilization increased from 65% to 68%.
- Decommissioned 50 EMC CLARiiON CX700 disk arrays and redeployed optimized capacity on 11 new CLARiiON CX4 arrays.
- Reducing storage capacity and deploying new disk arrays with higher density and lower energy costs avoided $1.2 million in disk array capital equipment costs and saved an estimated $2.8 million in power, cooling, and data center space costs over the next five years.
- The storage managed by each full time engineer was increased to 290 TB by the end of 2009.
- Retained backup capacity was reduced by 700 TB with new Oracle and SQL database retention policies.
- The number of physical tape libraries was reduced by 60% and the number of virtual tape libraries was reduced by 53%.

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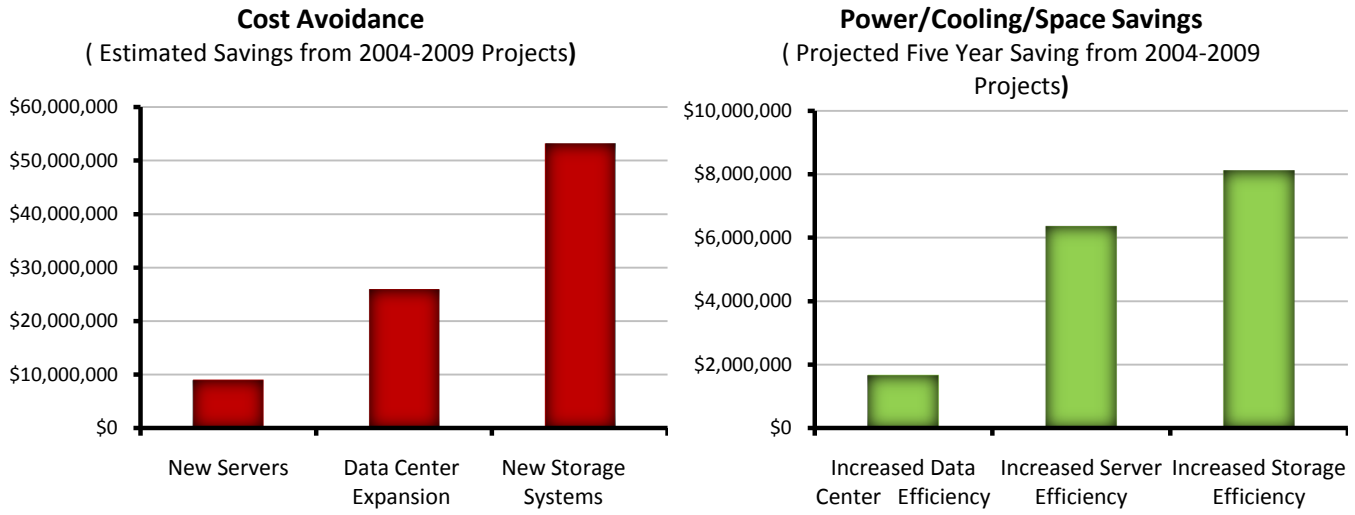
- Remote backup and recovery manpower requirements were reduced from 6.5 to 0.2 FTEs with Avamar deduplication technology.
- Reduced annual IT by $1 million as remote backup and recovery success rates grew from 38% to 98%.
- Improved security and reduced risk with enhanced asset management, configuration, and provisioning processes for applications deployed on virtual (and physical) servers.
- Deployed security, auditing, and monitoring tools within virtual servers .
- Deployed a select few third party applications hosted within the cloud (e.g., salesforce.com).
- Deployed Data Domain data deduplication for data center backups (pilot project).
- Deployed enterprise flash drives (EFD) for cost effective Tier-0 database acceleration.
- Deployed 600 virtual desktops with a goal of improving the productivity, security, and satisfaction of EMC's worldwide workforce.

Figure 4 summarizes the bottom line savings that have been realized between Jan 1, 2004 and Jan 1, 2010. The red bars show dollars that EMC avoided spending while the green bars depict power, cooling, and space savings from increased efficiency. ***All told, EMC's journey from 2004 through 2009 has resulted in savings of $104.5 million including an estimated $80 million in capital equipment cost avoidance and $19 million of operating cost reduction due to increased data center power, cooling, and space efficiency.***

Figure 5. EMC IT Savings: Journey to the Cloud (2004-2009)



Source: Enterprise Strategy Group, 2009.

To really get a sense of the impact that these IT efficiency and cost savings efforts have, here is an important statistic: ***between 2005 and 2009, EMC limited its IT infrastructure budget growth to only 8% while revenue grew at 30% and company headcount grew by 36%.[4] Not only did EMC realize more than $100 million in savings during this time, the cost of IT as a percentage of revenue was reduced by 20%.*** That level of efficiency and cost savings hits you right between the eyes and encourages the continuation of the efforts underway.

These consolidation, virtualization, and efficiency efforts have also resulted in improved CPU, storage, and memory utilization, making all resources more productive. Operational improvements have allowed staff to focus on higher-level infrastructure management activities. The organization has become significantly more agile as it responds to user requests faster. Put it all together and it's clear that EMC is realizing the advertised benefits of the private cloud.

[4] Excluding VMware revenue and IT infrastructure costs

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The Bigger Truth

While recent economic realities have placed an even greater than usual emphasis on cost reduction, that is not the only task of the IT manager. If it were, their jobs would be much easier. Instead, they must reduce costs while maintaining and continuously improving service levels, maximizing application and data availability, reducing risk, and increasing user satisfaction. They occupy a unique space in the industry as they are responsible for both supply and demand: to make their users more productive, they create demand for compute power, network bandwidth, and storage capacity based on business process and application requirements—and then they must find a way to supply it all.

EMC recognized the need to improve efficiency a decade ago and began to build a foundation for improvement. It has achieved stunning results in 2004-2009 by focusing on data center optimization, virtualization-enabled utility computing, and both private and public cloud deployments.

At this 2010 checkpoint, EMC has expanded its server virtualization efforts and now runs more virtual servers than physical ones. With many new initiatives already begun, EMC expects not only to continue to save, but to accelerate the value of its efforts in tiering, virtualization, and automation.

EMC has learned important lessons along the way about the impacts of this type of change on processes, organizational structure, and employees. Changing behavior is not as simple as changing technology. Planning, project management, process management, and budgeting can make a world of difference. Implementing a cloud-based infrastructure can change the nature of your IT department as well as your user experience—so it's important to ensure that those changes are both desired and planned for.

EMC's journey to the cloud began well before "the cloud" became a popular marketing term. While some may argue about what the cloud is, an ESG audit of EMC's three-phase journey has proven what the cloud can do for an organization. All told, EMC's journey from 2004 through 2009 has resulted in an estimated savings of $104.5 million. As the annual rate of savings accelerated to $17.3 million in 2009, it became clear that EMC has created a brilliant blueprint for the journey to the private cloud.

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