White Paper

EMC IT'S JOURNEY TO THE PRIVATE CLOUD: SERVER VIRTUALIZATION

A series exploring how EMC IT is architecting for the future and our progress toward offering IT as a Service to the business

Abstract

This white paper outlines the journey of EMC IT in implementing server virtualization and consolidation to offer *Compute as a Service* to business units. EMC IT is following a step-by-step approach toward the consolidation and migration of applications to realize a 100 percent virtualized server environment. This paper covers the strategy, knowledge gained, and benefits realized during this transition.

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Executive summary

The role of IT is evolving from that of a traditional cost center to being seen as a strategic organizational asset, able to facilitate transformation, drive competitive differentiation, and boost organizational agility in today's business *environment*.

EMC IT is playing a part in this evolution by taking a structured, planned, and phased approach toward private cloud adoption. Pivotal to this journey are EMC IT's server virtualization and consolidation efforts, which are designed to optimize both the utilization and elasticity of data center resources, while reducing costs. They are enabling EMC IT to build a new hosting platform on a tiered and shared service model that facilitates the delivery of Infrastructure as a Service (IaaS)[1] to EMC internal customers in an efficient and transparent manner.

To achieve its goals, EMC IT is employing a three-phased server virtualization and consolidation strategy. Phase 1, the Virtual Hosting Platform Project, involves the build out of a scalable, flexible, and virtualized IT infrastructure, and the institution of a "Virtual First" approach for implementing all new applications. Phase 2, the "Sweep the Floor" Project, encompasses the migration of applications running on over 1,600 non-clustered, physical Intel servers to a new consolidated, VMware-based virtualized environment. Phase 3, the Data Center OS Project, addresses the migration of more challenging, non-Intel-based and clustered platforms to the new virtual infrastructure. This effort is in line with EMC IT's goal of achieving a 100 percent data center virtualization by 2012 with all applications and their components running on the VMware vSphere™ cloud operating system.

Support from senior management; the development of governance policies and procedures; and in-depth research, planning, and study have been vital to the success of this initiative—as well as the ones that have followed on EMC IT's journey to the private cloud. All have contributed in enabling EMC IT to reduce the challenges in moving to a shared ITaaS model. For this particular initiative, working closely with partners and third parties to find ways of delivering their existing products and solutions in a virtualized environment was also a key factor for producing a successful outcome, as was the ability to build end-user confidence in the virtualized platform.

Today, EMC IT is reaping many benefits from this new model. Server virtualization and consolidation have drastically reduced provisioning time and increased flexibility and sharing, which have helped optimize utilization. EMC IT also anticipates it will realize more than $24 million in savings in five years from continued Phase 1 and Phase 2 rollouts by moving new applications to a shared infrastructure. In addition, EMC IT expects better return on IT investments based on the efficient and joint use of the IT infrastructure and improved planning and control of IT resources.

[1] Infrastructure as a Service contains compute, storage, and backup and recovery.

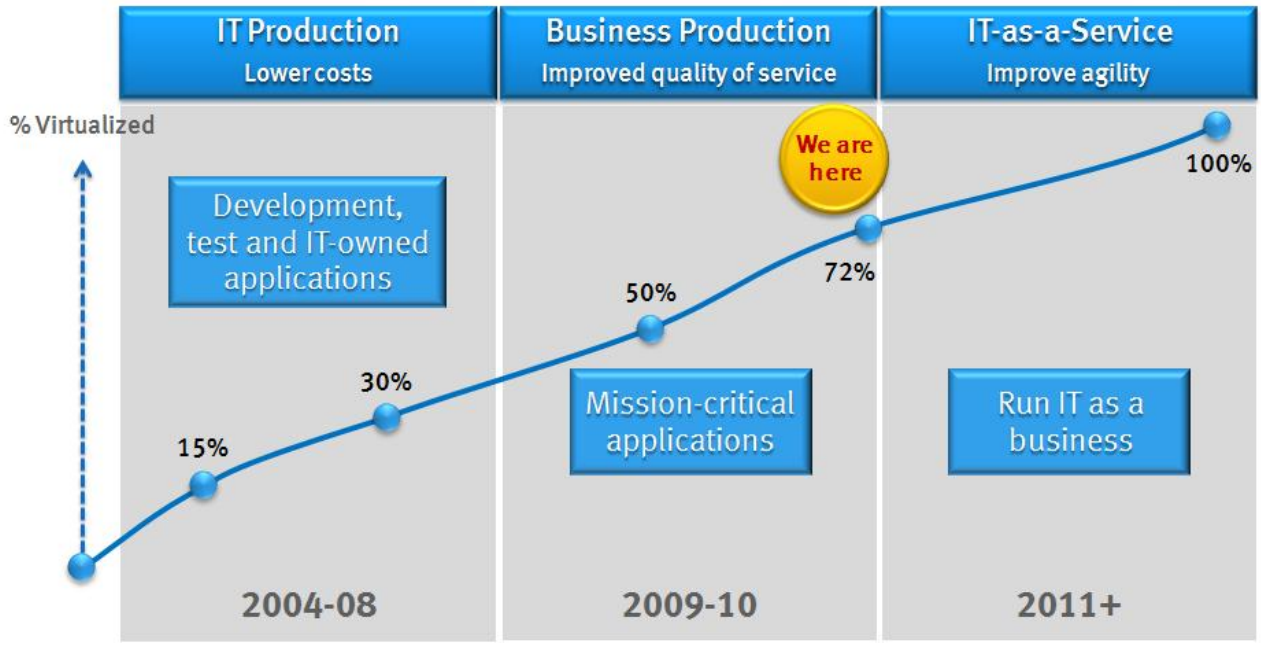

Figure 1. EMC IT achieved a remarkable 72 percent virtualization of its server environment

This white paper is part of a series of papers on EMC IT's journey to the private cloud. To learn more about this initiative, please see EMC IT's Journey to the Private Cloud: A Practitioner's Guide.

Introduction

This white paper describes in detail EMC's journey toward achieving a complete, 100 percent virtualized infrastructure environment. It offers key insights into the design and development of the virtualized and consolidated hosting platform that EMC is building to offer Compute as a Service to its business units. It includes the following sections:

- Background—This section introduces the context for server virtualization.
- Compute as a Service through server virtualization and consolidation—This section elaborates on EMC IT's stepwise approach toward implementing server virtualization and consolidation.
- The Virtual Hosting Platform Project—This section describes the first step in offering Compute as a Service to business units, which began with the design and deployment of a scalable, flexible, and virtualized hosting platform based on existing technologies and best practices. EMC IT also instituted its "Virtual First" approach, which requires all new applications to be hosted on the new infrastructure.
- The "Sweep the Floor" Project—This section details how EMC IT managed and moved existing physical solutions to the virtualized VMware infrastructure.

- The Data Center OS Project—Currently in progress, this endeavor deals with the migration of the more challenging non-Intel-based and clustered platforms to the virtualized environment. This includes small and medium databases running on Linux and large clustered Solaris databases.
- Use case: Microsoft® Exchange—This section provides an EMC IT example for delivering a business-critical service through a virtualized environment.
- Key findings and best practices—This section outlines the many factors crucial to the success of virtualization.
- Benefits realized by EMC IT through server virtualization—This section highlights the many advantages EMC IT, and the overall organization, have gained from the initiative so far.

Audience

This white paper is intended for IT architects and administrators, managers, business analysts, and key stakeholders.

Background

Today, expectations for IT departments have evolved from merely supporting the business to actively partnering in its growth. As a result, businesses are turning to organization-wide IT solutions to support business objectives to increase savings, respond quickly to market changes, and drive competitive advantage.

EMC IT's vision is to transform the IT department into an operation that is efficient, customer-centric, service-oriented, and based on standardization. Virtualization technologies and the private cloud are enabling EMC IT to realize its goals.

The server virtualization and consolidation initiative is designed to enable EMC IT to offer Compute as a Service to internal departments, allowing for increased efficiency as well as the ability to handle greater variability and flexibility in server operations.

Reducing capital expenditures by facilitating server optimization, and lowering operational expenses through more efficient server management, are the immediate goals of virtualization. It also plays a role in bringing down power and cooling costs because a consolidated virtual environment needs significantly less energy and space than physical servers in a traditional environment typically require.

The strategic goal of this EMC IT initiative is to drive the adoption and acceptance of compute as a shared and elastic infrastructure. This infrastructure will be offered to business units as a service, depending on their requirements, and will help EMC IT improve processes, enhance efficiency, accelerate deployment, and reduce costs through usage-based, metered chargeback or showback models.

Compute as a Service through server virtualization and consolidation

EMC's rapid and sustained growth has put significant pressure on its existing IT infrastructure and imposed greater demand on services. Its data centers were operating above recommended capacity and were running out of power and floor space.

While the total cost of ownership (TCO) and consumption of data center resources were on the rise, resources were not being utilized to their optimal capacity. Despite server underutilization, EMC business units were budgeting for new servers to meet their project needs. In addition, several departments owned and controlled their own point solutions to accommodate peak load requirements, but under normal operating conditions the majority of provisioned capacity remained underutilized. As a result, depreciation and maintenance costs as well as power and heating requirements continued to escalate.

To overcome these challenges, EMC IT launched a server virtualization and consolidation initiative based on the following three pillars:

- **Consolidation**—A shared IT infrastructure eliminates the point solutions that challenge the effective utilization of IT assets.
- **Standardization**—Hardware, operating system, and application-specific requirements are eliminated and replaced with a tiered service model based on standardized service catalogs.
- **Measurable cost structures**—IT silos are replaced by a flexible, shared IT environment with a cost structure based on pay-per-use.

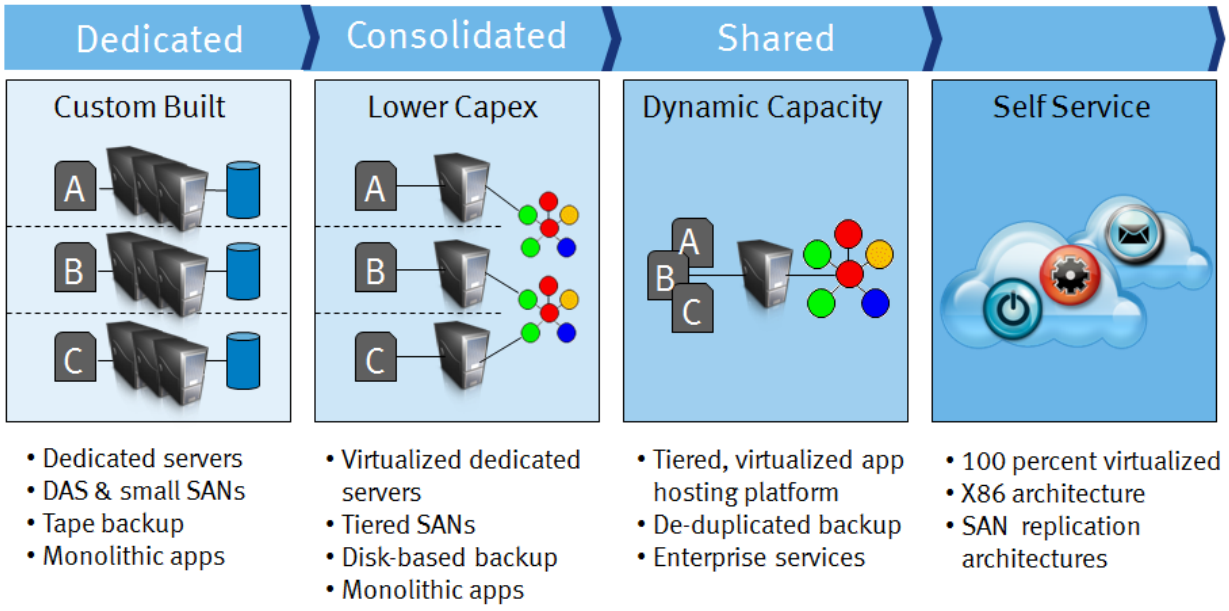

Figure 2. The virtualization journey

The focus of this initiative was to develop a new hosting platform built on a service paradigm—tiered and shared. The ultimate goal for the entire IT infrastructure is to be 100 percent virtualized and consolidated with a ratio of 15:1. This not only means that all new applications will be hosted on this virtualized infrastructure, but it will also involve migrating more than 400 applications hosted on 1,600 existing servers to the new platform.

As with any initiative of this scale, securing the support and agreement of all departments is critical. Therefore, EMC IT enlisted the cooperation and buy-in from all business units. EMC IT achieved this by addressing each unit's concerns regarding the transition of physical applications to a new virtual infrastructure, and outlined the benefits of efficiency and savings that each would realize through EMC IT's carefully crafted, three-phase server virtualization and consolidation strategy.

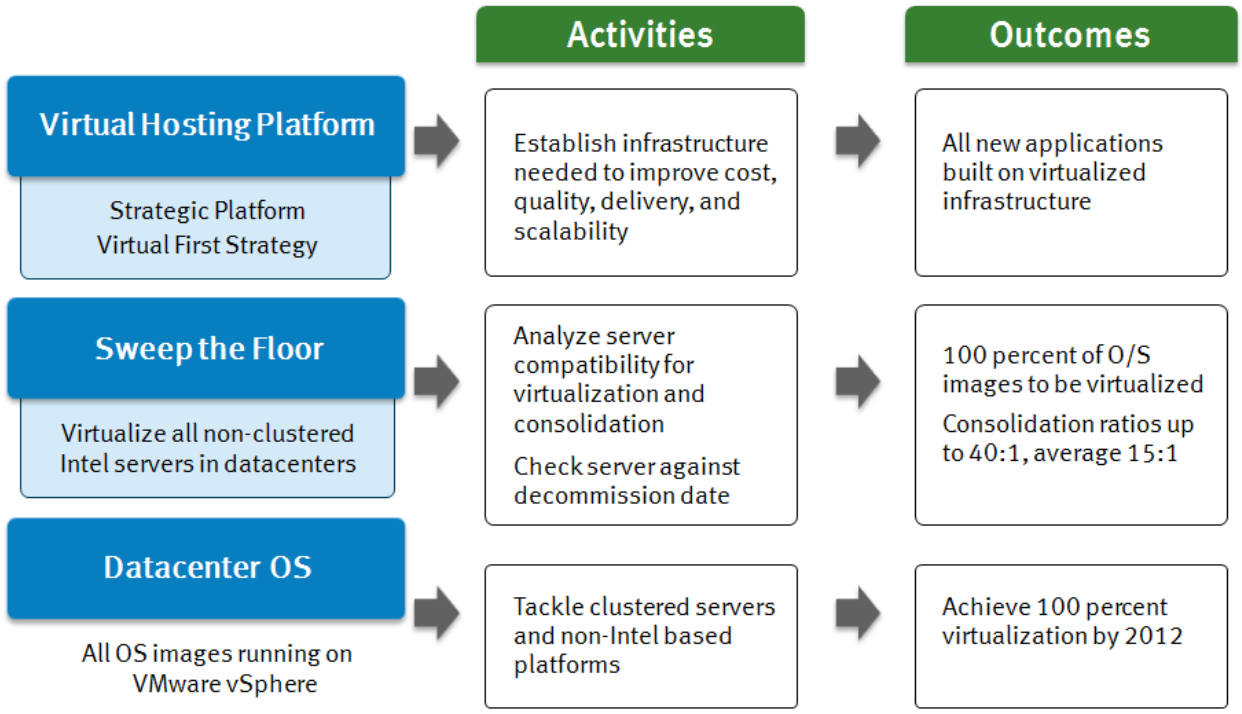

Figure 3. EMC IT's Server Virtualization and Consolidation Program

The Virtual Hosting Platform (VHP) Project

The VHP project was structured to reduce the development cost for new projects, enhance EMC IT's agility to deliver faster provisioning, and reduce the time necessary to bring new applications online. The objectives of the VHP project were realized by:

- Providing a scalable, flexible, and best-in-class virtualized infrastructure that offers business units ready-to-use compute facilities in a tiered services model.

- Implementing a "Virtual First" strategy – a prerequisite requiring all new applications to be hosted on the new virtual infrastructure.
- Reducing the time to provision new infrastructure by leveraging this ready-made infrastructure platform.
- Increasing the number of applications hosted per server to realize better returns on IT investments.

The mandate of the VHP project was to merge "islands" of virtualized application environments into large virtualized farms, enabling hyper-consolidation of servers—the server equivalent of SANs. This effort is driving consolidation ratios of up to 15 virtual machines per physical server. It also circumvents the need to purchase at least 600 servers at a cost of $13 million over the next five years.

A critical success factor for server virtualization is deciding on a server standard and a common vendor. To get the most cost-efficient system and the lowest TCO, EMC IT needed a single standard that is applied consistently to avoid unnecessary complexity and interoperability challenges.

Prior to deciding the configuration of the devices to be used for building the platform, EMC IT performed an in-depth analysis of the various server vendors and their products based on cost-effectiveness as well as technical and business benefits. Leveraging this analysis, EMC IT put parameters in place for the new platform and selected a configuration comprising four quad-core Intel Xeon processors, with a total of 16 cores per server, and 128 GB of RAM. This infrastructure was procured and used to build the new virtual hosting platform.

EMC IT worked with VMware to design farms and specify the standard server configuration that was to be implemented. Existing applications were migrated to new farms as their current hardware platforms reached end of service.

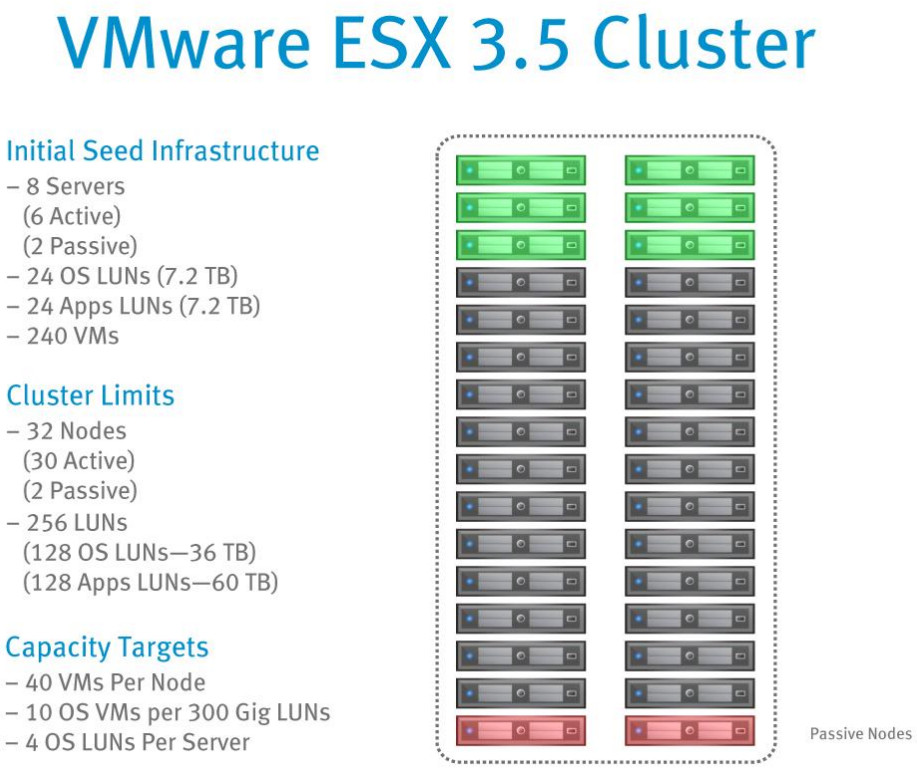

Figure 4. Configuration of server platforms using VMware ESX 3.5

The initial deployment of the platform was on six servers using a VMware® ESX® 3.5 server. This six-node structure had 24 OS LUNs and 24 application LUNs with 7.2 TB capacity for each. Approximately 240 virtual machines were deployed in the initial phase.

The cluster, with full capacity, is configured for a limit of 32 (30 active and 2 passive) maximum nodes per cluster, and 256 maximum LUNs per cluster—128 OS LUNs and 128 application LUNs. The capacity calculation is 40 virtual machines per node, 10 OS virtual machines per 300 GB LUN, 4 OS LUNs per server, and hence 120 OS LUNs. The maximum limits were kept under VMware's maximum permissible cluster limits (32 maximum nodes per cluster and 256 maximum LUNs per cluster).

The seed infrastructure was built using core design principles that were important to drive IT agility and business enablement:

- **Cost**—Built on best-in-class commodity hardware, the seed infrastructure ensures the highest return on investment.
- **Quality**—To meet or exceed service-level agreements (SLAs), the infrastructure was designed to deliver the highest uptime and availability.
- **Delivery**—The infrastructure was architected to facilitate capacity on demand with the fastest build time and the lowest mean time to repair and change objectives—all while ensuring the capability of a flexible chargeback model.

- **Scalability**—Structured to ensure horizontal and vertical scalability for both infrastructure and services, the seed infrastructure will also support mergers and acquisitions.

The key determinant of required service levels is the criticality of the application to the business, and whether it faces internal or external customers. The servers were categorized into Tier-1, Tier-2, and Tier-3 types based on their different service-level expectations. Tier-1 servers hosted public-facing, mission-critical applications. Tier-2 servers hosted other public and private applications that were business-critical. Tier-3 servers hosted business-supporting applications and development and test environments. These servers were further clustered into two, with Tier-1 servers in one cluster and Tier-2 and Tier-3 servers in the second cluster.

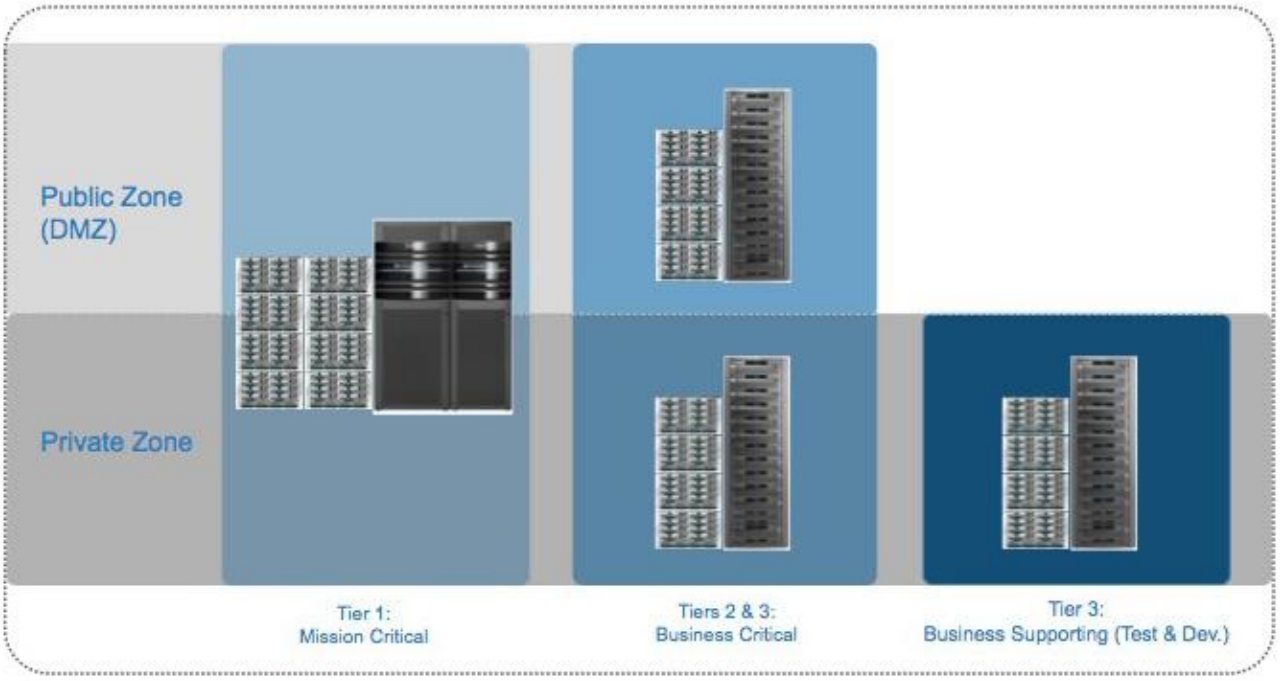

Figure 5. Servers were categorized into Tiers 1, 2, and 3 based on service levels

The hosted platform provides a foundation for delivering Compute as a Service.

The "Sweep the Floor" (STF) Project

EMC IT's next objective was to transition 1,600 Intel-based servers onto the new virtualized server infrastructure to increase the efficiency and utilization of data center and system resources.

Before embarking on the server virtualization project, EMC IT carried out detailed analysis to avoid any technical or business issues, and conducted thorough assessments of the applications to ensure that there were no performance or hardware restrictions that could limit the virtualization or consolidation work. Applications slated for decommissioning in the near future were not virtualized. This

made the entire process simpler to manage and increased the efficiency of the virtualization initiatives.

Adopting a pragmatic approach with regard to the existing infrastructure, EMC IT attempted to leverage as many existing tools and processes as possible. The virtualization efforts therefore included detailed planning of the development, support, and operation of the IT infrastructure. This included identifying necessary changes to major systems and tools that would be required to support applications in the new virtualized environment.

By implementing the STF project, EMC IT was able to deliver more than $13 million in cost avoidance over a five-year timeframe. To date, the combined efforts of the VHP and STF projects have enabled EMC IT to virtualize 70 percent of its infrastructure and achieve an average server consolidation ratio of 15:1.

The Data Center OS Project

EMC IT's server virtualization and consolidation efforts have been well guided by a highly defined, incremental approach that is expected to culminate with the end goal of 100 percent virtualization on the VMware vSphere platform by 2012. On target to meet that goal, EMC is currently working to migrate all other existing applications.

Following the successful migration of non-clustered Intel-based servers, EMC IT is now focusing its efforts on transitioning the more challenging clustered databases, currently hosted on various platforms (for example, Linux and Solaris), to the virtualized environment. In addition, EMC IT is working on methodologies to migrate complex database grids to a VMware-based platform. This will help facilitate the move of all eligible applications to the virtualized platform, and provide a virtual data center that is flexible, scalable, and elastic.

Use case: Microsoft Exchange

A successful example of delivering a service through a virtualized environment is EMC's business-critical Microsoft Exchange platform. Today, all of EMC's Microsoft Exchange servers, as well as 64,000 mailboxes, run from a completely virtual environment. This was achieved by leveraging a building block approach for the construction of the infrastructure, with each building block supporting around 16,000 mailboxes.

By regionalizing the design, EMC IT has reduced mailbox transfers while simultaneously supporting 99.99 percent availability, 100 percent disaster recovery protection, and an ability to recover to the last transacted logs.

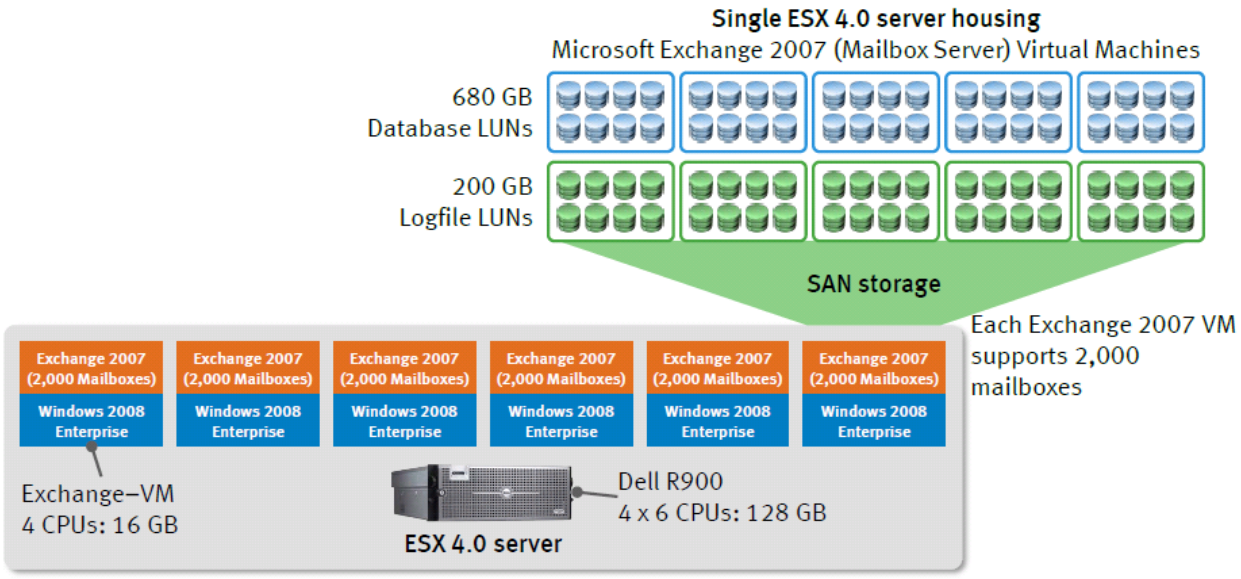

Figure 6. Sample architecture of a 16,000-mailbox building block hosting Microsoft Exchange servers on a virtualized environment

Key findings and best practices

As EMC IT approaches its desired goal of a 100 percent virtualized IT infrastructure, it has learned some invaluable lessons. In addition to having a well-planned strategy in place to address the technical complexity of virtualization, there are many other factors outside of the technical realm that must be taken into consideration to help ensure success. These include:

- **Management support**—As with any organizational change, the onus of bringing internal units together is on the leaders. In large organizations, where processes are set, leaders must address resistance by winning their teams' confidence through comprehensive knowledge and a plan for success. Support from senior management plays an important role in breaking organizational silos and helping business units transition from a dedicated, tightly controlled IT infrastructure to a shared, service paradigm.
- **Governance and policies**—Not only is management support important for the adoption of this model by various internal business units, but it is also imperative for defining governance and policies. A successful implementation of virtualized infrastructure must be supported by appropriate governance policies and procedures, which are critical for efficient and effective provisioning of IT as a Service.
- **Planning and research**—In-depth research, planning, and study create the foundation for a smooth transition from physical IT to virtualization and the cloud. Supporting sound preparation, these studies help identify and sequence the best

candidates for transition, reducing the challenges in moving to shared IT as a Service model.

- **Sound partner relationships**—Since IT support varies according to the diverse needs of businesses, projects, and functions, companies must work closely with partners and third parties to find ways of delivering their existing products and solutions in a virtualized environment.
- **Building confidence in end users**—The goal of virtualization and cloud computing is to increase productivity and facilitate a problem-free experience. Building confidence in end users regarding the virtualized operating environment is critical. As a means of evangelizing the virtualized platform among business units, it is important to present credible examples of mission-critical applications already running successfully on a virtualized infrastructure. In addition, providing business groups with sandboxes for virtualization, where applications can be run and tested before a full-scale migration occurs, is helpful. A number of business units within EMC have used this approach prior to moving their business-critical applications to the new virtualized IT infrastructure.

Benefits realized by EMC IT through server virtualization

EMC IT began its journey toward a private cloud-based IT infrastructure through server virtualization and consolidation. Its server virtualization and consolidation initiative was considered a means to provide computing capacity as a service to the business units at EMC. This model offers many benefits to EMC IT and the organization as a whole.

- **Reduced delivery time**—While server virtualization and consolidation offer a drastic reduction in delivery time, it will also enable EMC IT to increase the utilization of its existing infrastructure through enhanced flexibility and sharing.
- **Increased savings**—To date, more than $24 million in cost savings has been realized from the VHP and STF projects by moving new applications to the shared infrastructure. As the Data Center OS phase progresses, EMC IT is looking to realize benefits from this project in terms of new IT infrastructure investment cost avoidance, lower upkeep and maintenance costs, and reduced real estate and energy expenses.
- **Enhanced ROI**—EMC IT expects better return on its IT investments due to more efficient, shared use of the IT infrastructure, and improved planning and control of IT resources. As the OS phase progresses, ROI is expected to increase.
- **Optimized utilization of infrastructure**— EMC IT's intention is to move toward a complete services model for provisioning the server infrastructure. In this model, the central IT team will deliver IT resources on-demand to business units, with provisioning based on actual rather than peak loads. Additionally, EMC IT is striving to make IT resources completely elastic and interchangeable through a consolidated and shared IT resource pool. This will enable EMC IT to drive

efficiencies by utilizing the free capacity of projects in lean periods to fulfill the requirements of other projects facing a peak load at that time.

Conclusion

The structured and planned approach that EMC IT followed in implementing server virtualization and consolidation enabled a smooth transition to a virtual platform.

The first step was to build the infrastructure and institute a "Virtual First" approach for hosting all new applications on this platform. The platform was chosen after careful evaluation of the required parameters that were needed to support EMC in its growth. An in-depth study of vendors ensured that products had the right standards and consistency needed for the long-term success of the initiative.

The next two phases encompass the migration of physical Intel servers, as well as non-Intel-based and clustered platforms, to the virtual infrastructure with the objective of achieving a 100 percent data center virtualization by standardizing on the VMware vSphere platform. This stepwise approach allows EMC IT to ensure that all technical aspects are taken into consideration, and that the businesses have the reassurance they require to move to the new virtual paradigm.

Offering Compute as a Service has already yielded benefits to EMC IT and the business units that are their internal customers. For EMC IT, there are the advantages of increased efficiency, the ability to handle greater variability, and improved flexibility in server operations. There is also reduced capital expenditure through server optimization. In addition, the server virtualization and consolidation initiative has reduced operational expenses by way of less cooling, storage, and maintenance.

Business units are also finding benefits gained through improved processes and enhanced efficiency that server virtualization and consolidation enable. They are also seeing the advantages of reduced costs through usage-based and metered chargeback, or showback models.

The tipping point was achieved in Q1 2010, when the number of virtual servers exceeded the number of physical servers for the first time. EMC IT intends to keep up the momentum into 2012, working toward the goal of 100 percent server virtualization.

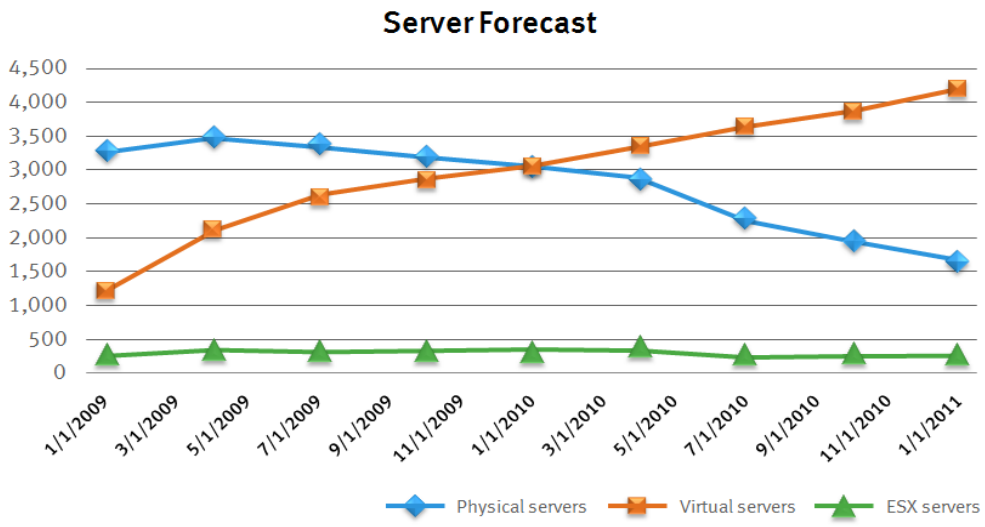

Figure 7. Virtual server growth exceeds physical server growth

References

The following links provide additional, relevant information. You can access these documents at www.EMC.com or by contacting an EMC representative:

- EMC IT's Journey to the Private Cloud: A Practitioner's Guide
- EMC IT web page at http://www.EMC.com/EMCIT
- Storage Best Practices for SharePoint and SQL Server recorded webcast