EMC DURHAM VIRTUAL DATA CENTER
Application & Data Migration

EXECUTIVE SUMMARY
In December 2012, EMC completed migrating its corporate data center from Westborough, Massachusetts, to a new energy-efficient, 100% virtual data center in Durham, North Carolina.

The migration required the relocation and transformation of more than 350 applications, 2,500 servers, and six petabytes (6 PB) of critical data used by over 60,000 employees worldwide.

All of the application migrations were completed in less than two years. The data center project from kickoff, site selection, construction, and application migration was completed in less than four years.

DURHAM PROGRAM JUSTIFICATION
The Durham Data Center Migration Program was part of a larger EMC Corporate Facilities initiative to consolidate, modernize, and drive down the cost of IT and EMC’s engineering labs.

Several of the buildings that EMC occupied were leased, obsolete, or both. EMC’s Westborough data center was located in a leased building. The data center power distribution and HVAC equipment was inefficient, nearly at capacity, and nearly end of life. A major investment would be required to upgrade the existing infrastructure.

The high cost of power in Massachusetts was also a driving factor in the decision. North Carolina was quickly identified as an ideal location because of its business-friendly policies, affordable and available power, and talented educated workforce.
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**ARCHITECTURE**

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**MIGRATION STRATEGY**

Private clouds were a fairly new concept back in 2009. The Durham migration needed to be a showcase for EMC’s private cloud vision. A new data center migration approach had to be demonstrated without doing a physical move.

Traditionally, data centers were moved in the same way you would move your family. You would carefully pack and load everything in a truck, drive it to your new home, and then unpack and set up in your new location. Just as moving your family creates a major disruption to your life, so does moving a production data center in today’s 24x7, always-on business.

To minimize the risk and disruption to their business users, EMC decided to migrate and transform to a new private cloud, built on VCE Vblock™ converged infrastructure, 100 percent virtualized on VMware® vSphere.

Hardware was not relocated to the new facility as part of the data center migration. Instead, applications and data were moved across four redundant 10-gigabits-per-second WAN links. Additionally, many application physical server architectures were rebuilt, to new virtualized cloud architectures.

The migration strategy challenged every traditional migration best practice.

**PROGRAM STRUCTURE/GOVERNANCE**

The EMC IT organization has considerable experience integrating applications, infrastructure, and operations into its data centers from the many acquisitions the company has conducted. However, they had not previously managed migration on such a large scale.

To minimize risk, EMC IT engaged EMC Consulting to help plan and manage its data center move.

EMC Consulting worked with EMC IT to discover, analyze, and plan the migration of applications and data from the source environment.
EMC and VMware Professional Services were also engaged to augment EMC IT staff and bring in proven industry best practices. EMC’s storage experts installed and configured the new storage arrays, and designed and built the new DR replication technology. VMware Professional Services assisted building out the new virtual infrastructure and executing the migrations.

Project and program managers from all four organizations rolled up to form the Program Management Office. They reported up to an Executive Steering Committee consisting of executives from throughout EMC.

**Executive Steering Committee**
IT, Consulting, Services Sr. Mgmt

**Program Management Office**
IT, Consulting, And Services PMs

**EMC Consulting**
- Large Data Center Migrations Leadership
- High Level Program Estimates
- Proven Methodology

**EMC Services**
- Install Configure Storage And SAN Gear
- Design Build DR Replication
- Plan And Execute Storage Migrations

**VMware Professional Services**
- Help Design And Build Virtual Infrastructure
- Plan And Execute VM Migrations

**EMC IT**
- Build And Configure Data Center Infrastructure
- Communicate To Business
- Execute Application Migrations
- Customer

**PROGRAM MANAGEMENT OFFICE**

The PMO coordinated, communicated, and synchronized activities through all phases of the migration.

The PMO was critical in keeping dozens of interdependent migration work streams with hundreds of projects in flight coordinated and moving forward.

- **Daily Standup**—The PMO ran a 30-minute daily meeting for the duration of the program in order to track all of the infrastructure and migration deliverables.

- **Status Reporting**—Status reporting on the overall program and detailed status of the migrations and projects in flight were done weekly.

- **Communication**—Over communicating on a program this large is impossible. The Daily Standup minutes were distributed to the entire program team and much of EMC IT. The weekly status report was distributed to an even larger audience that included leaders from various business units. An internal social media site was set up with data center pictures, status, and schedule information available to everyone in EMC. The Program Leadership team held regular, live “Town Hall Meetings” with the EMC IT global community. Business owners were apprised of progress, schedules, and issues affecting their applications. As the migration proceeded, some Town Meetings were expanded to include the greater population of EMC employees.

- **Escalation**—The PMO was responsible for resolving issues. Most of the issues were technical/resource constraints that could be overcome by rescheduling an individual application to another Move Event or creating a dedicated Migration Event for that application.
PROGRAM SCHEDULE

The EMC Durham Data Center Migration Program was initiated in early 2009. Less than four years later, the new facility was purchased, remodeled, and all of the applications migrated. The application migration itself was completed in less than two years.

The scope of the data center migration from Westborough to Durham included: a total of 350 applications (54 mission-critical, 84 business-critical, and 209 business-important); over 2,000 virtual machines; over six petabytes of data; 115 storage arrays; 28 SAN switches; and 20 network switches. All of EMC’s mission-critical applications were in scope.

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**Program Management Office - Data Center Migration**

- **Arch IT Architecture Design**
- **First 90 Days**
- **Foundation**
- **Foundation Applications**
- **Incremental Capacity**
- **Discovery And Analysis**
- **Migration Planning**
- **Migration Execution**
- **Legacy Data Center Decommission**

ARCHITECTURE

The new Durham cloud data center is fully standardized on a single version of the VMware vSphere™; on an x86 enterprise hosting architecture, built using the VCE Vblock converged infrastructure. This standardized virtual infrastructure provides the foundation for cloud that will enable EMC IT to locate and easily move workloads transparently within the Durham data center for maximum efficiency, performance, and utilization. The architecture includes:

- **Network**: 4 Redundant 10 GB/s WAN links, Cisco Nexus 7000 core network
- **Compute**: Cisco UCS x86 servers, 100% virtualized
- **Storage**: EMC Symmetrix VMAX, EMC VNX
- **Backup**: 100 percent tapeless using EMC NetWorker®, Avamar®, and Data Domain®. Backups are created locally in each data center and then replicated to the remote data center.
EMC hosts all its mission-critical applications in two primary data centers - Hopkinton, MA and Durham, NC. Each data center acts as a DR site for the other. For disaster recovery, EMC used SRDF®/Star and VMware Site Recovery Manager.

EMC’s ERP and CRM mission-critical applications have a requirement for zero data loss. The network latency across the 600 mile distance between the MA and NC data center is 25 milliseconds. Synchronous replication latency has a limitation of 5 milliseconds. Therefore EMC built a bunker site at their Franklin MA site, well within the 5 ms limit. A second Symmetrix VMAX was installed in the bunker. For all “writes” the data is written to both the primary and the bunker site VMAX storage arrays. From the bunker, the data is then asynchronously replicated to Durham. The bunker data copy protects the applications from a primary data center loss. The Durham data copy protects the applications from a regional disaster, like Hurricane Sandy, with only a few minutes of data loss.

Other applications or components that do not have a zero data loss requirement replicate asynchronously using SRDF/A.

In addition the mission-critical VM infrastructure is protected with VMware Site Recovery Manager (SRM). SRM manages and automates most of the re-configuration work required to failover VMs to the DR site.
DISCOVERY AND ANALYSIS

The EMC IT Program Leadership team was skeptical that the migration’s Discovery and Analysis phase would take the nine months allotted in the initial program plan. The concept was to “discover everything before planning to move anything.” Intensive effort was necessary to be sure that potential issues were identified, documented, and planned for upfront to avoid surprises and complications later, when the impact on move event plans and schedules would be far reaching. In a traditional data center migration, once the truck is gone, it would take many hours or days for mistakes to manifest themselves and even more time to identify and ship the remaining components.

In the years prior to virtualization, EMC IT overcame the constraints of under utilized physical servers and constant demand by adding more applications and environments to existing servers. Servers were grouped together to create Application and Web tier farms. Database servers became database grids. As a result, the variety of OS, Web server, and database vendors and versions basically resulted in everything being connected to everything except for the largest application infrastructures like ERP. There was no compelling reason to rationalize the environments during the initial race to virtualization. To minimize effort, EMC’s earlier virtualization projects virtualized the servers as-is. It was okay to “physical-to-virtual” (P-to-V) one server at a time in the same data center, but the challenge of moving an application as whole was much more complicated by the multi-tenant server sprawl.

- **Data Discovery**—EMC data center migration consultants conducted workshops and collected data from existing systems on assets supporting about 350 applications. Move event leads spent about three months interviewing business owners and technical experts to collect information on each of their assigned applications. This data included availability and performance requirements, and interdependencies with other applications, databases, and infrastructure. As is commonly the case, configuration and change management processes and systems in the existing EMC data center had not been kept up to date, increasing the effort required to ensure data was complete and accurate.

- **Validation and Analysis**—All discovery data was transferred to the Migration Access Database (MAD) repository, where it was validated and analyzed by EMC consultants. EMC IT, like many IT organizations, had long relied on multiple, siloed systems of record, with information about different technologies stored in different systems by different groups. Over the years, a number of “band-aid” tools and processes had been developed to try to keep configuration data up to date, including a home-grown application to map back information from physical inventories, maintenance contracts, and license agreements. Nevertheless, the validation process revealed that the data in the systems of record was not accurate or complete.
**Defining Move Bundles**—Once discovery data had been validated and analyzed, EMC consultants worked with EMC IT to create application move bundles—groups of applications that needed to be moved together to maintain the dependencies and integration required to deliver services. This effort, too, was complicated by the high degree of consolidation in the existing data center environment. For example, EMC IT was able to achieve a significant database server consolidation. These consolidations had significantly enhanced agility and cut infrastructure and operational costs. However, they had also resulted in many more applications relying on fewer databases and sharing the same grid infrastructure, complicating the defining and sequencing of move bundles. Because, in effect, “almost everything is connected to everything” in such a consolidated environment, separating out and defining bundles became more difficult. To address the issue, the team decided to make move events database centric. That is, application bundles would be defined by database grid dependency. Practically speaking, this means larger bundles of applications, but fewer move events. It also enabled clean, efficient array-to-array data migration.

![Image of Move Event Plan](image-url)

**REALITY IS NOT SCRIPTED**

The Move Event Plan (as shown above) was a vital program deliverable to communicate the schedule, determine conflicts, and let everyone know that their application migration couldn’t wait until the end. However, like all plans, unforeseen circumstances and resource conflicts required some last minute flexibility. Many applications needed to move on their own. Since EMC was migrating data over the wire they had the flexibility to peel out individual databases or applications and set them up on new virtual machines.

EMC also organized all the mission-critical applications into dedicated moves, with a planning and build cycle that exceeded the original 10-week planning horizon. The PMO was responsible for approving and coordinating all of the schedule changes.
MIGRATION TECHNOLOGY AND TOOLS

Right before the Durham migration, EMC IT had completed an aggressive project named “Sweep the Floor” and virtualized about 60 percent of the servers in the data center. For those virtualized servers, EMC first evaluated the feasibility of direct virtual-to-virtual migration (V-to-V) between the sites. However, the distance and latency made the V-to-V process too slow. It would never scale given the volume of servers and applications.

The team designed and built a migration bridge between the sites. A small EMC Symmetrix VMAX® was set up in both data centers along with an SRDF/A link. For each application or move event migration, LUNs were set up and replicated. The applications and data were moved using a combination of VMware Storage VMotion™ and EMC SRDF data replication software.

As part of the Durham program, VMware Site Recovery Manager (SRM) was installed for DR automation of mission-critical applications like the SAP ERP environment.

There were still hundreds of physical machines. Storage VMotion wouldn’t work for them. Nearly every database was running on a physical server and many older applications were as well. EMC IT debated whether it made sense to P-to-V the servers and then migrate them. It would be a lot of work, nearly doubling the number of migrations. Instead, new VMs were built in Durham. The old physical gear would be left as is and in parallel new servers were built. The application teams capitalized on the opportunity to upgrade and upsize their environments. New VMs were built on newer OS and database versions with more vCPU’s and vRAM memory than physical machines. Since the physical machines were still plugging away, the application teams had time to test and configure their new VMs prior to the migration.

MISSION-CRITICAL MIGRATIONS: REDUCING RISK FOR THE BUSINESS

For mission-critical applications EMC’s business units were unwilling to accept significant migration downtime and risk. For those environments entire new virtual infrastructures were built out in Durham and Hopkinton—either new VMs were built out or existing VMs were cloned.

Just like with the physical machines EMC IT was able to upgrade and scale out the infrastructure. EMC IT upgraded OS and database versions, added more servers, and allocated more vCPUs and vRAM. The application teams were able to configure and test the new architectures. Functional and performance tests were conducted as well as testing disaster recovery between the new environments. Most importantly, the migrations were practiced and every task was documented in a detailed playbook.

The ESRS 2 (EMC Secure Remote Service 2) migration is probably the pinnacle success story of the entire Durham migration. ESRS 2 connects EMC’s Customer Service organization to over half of their customer install base with a secure IP tunnel. It is extremely important to EMC and their customers. Pre-migration, the ESRS 2 application could barely keep up as the install base continued to grow. The migration team was able to quickly build out an entirely new virtual environment running on VCE Vblock. The ensuing performance test results were outstanding. The new architecture was tested at 4x the current load and ran much faster. EMC IT was able to pre-configure and test nearly every configuration point, minimizing migration risk and downtime. Pre-migration, they also tested and documented disaster recovery on the new architecture with no disruption to the legacy production environment.
For the migration itself, some network configurations needed to be moved from Westborough to Durham. To further minimize risk in order to always have an environment to failback to, it was determined that the migration to ESRS 2 would be first to its new DR site, then later in the day to the production site. It was a bold plan. ESRS 2 is EMC’s most mission-critical application and it was migrated successfully twice in the same day!

LESSONS LEARNED

Traditional data center migrations minimize risk by not making any changes to the applications or their infrastructure. EMC saw it as an opportunity to enhance both for their mission-critical applications while still able to minimize the risk to their business.

The lessons learned include:

• Executive management support is critical
• You’re only as good as your team
• VCE Vblock architecture is fast and flexible
• The SRDF migration bridge was very effective
• Migration over the wire increases flexibility and reduces importance of data interdependencies (bundling).
• Build parallel mission-critical environments
  o Opportunity to virtualize first and then migrate
  o Pre-configure and then functional and performance test
  o Practice migration and test disaster recovery
• Configuration management is critical to success

CLOSING

Based on lessons learned during the Durham migration, migrating over the wire to pre-built parallel environments radically simplified the planning and streamlined the execution.

EMC IT is currently in the process of beginning another data center migration. It is smaller scale and less time critical. Some dev, test, and business-important production applications that are running on legacy infrastructure in Hopkinton will be migrated to Durham. This time all of the applications will be moved to new pre-built, pre-configured, pre-tested architectures. This approach gives the application teams more time and flexibility to configure and test.

Also, the better part of a year will not be spent on determining all of the components and interdependencies for each application to come up with bundles and move events. It was demonstrated that any application code or database could be peeled out and installed on new VMs. Bundles and move events are obsolete.

Instead, the applications that need to move will be inventoried, and each one will be scheduled as an individual move to a new parallel environment. Also, rather than depending on a physical firewalls, VMware’s vCloud Network and Security virtual firewalls will be leveraged. The virtual firewalls can be configured to limit the ports and devices that can communicate to the application and its components and not rely solely on the physical firewall securing the perimeter.

In summary, EMC IT will be able to start sooner, increase flexibility, reduce risk to the business, reduce effort for the application teams, increase performance, increase security, and reduce downtime by building out new parallel environments.
BACKGROUND

EMC IT: THE TRANSFORMATION TO CLOUD

EMC Global IT delivers services to more than 60,000 internal users across 400 corporate offices in 80 countries. Operations span five data centers and host 500 applications and 13 petabytes of data.

To reduce costs, improve services, and enable business innovation and competitive advantage, EMC IT embarked on an IT transformation, moving from a physical to a virtualized IT infrastructure with more automated processes to deliver IT as a service (ITaaS). EMC’s vision is to offer the entire IT stack as a service through on-demand, self-service provisioning with metered usage for chargeback. As such, ITaaS capability spans server, storage, and network infrastructure; enterprise applications; databases; security services; virtual desktop services; and more—with the ability to draw infrastructure as a service and software as a service from a shared pool of virtual resources in EMC data centers and/or partner data centers across the globe.

REFERENCES

Read the following for more information:
http://www.emc.com/EMCITProven
EMC IT’s blog at http://itblog.emc.com/

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