NetApp®

Technical Case Study

How the City of Melrose Reached the Clouds with VMware on NetApp FlexPod

Abstract

Located approximately seven miles north of Boston, Melrose is a small city with a population of about 28,000. Since its settlement in the 18th century, Melrose has offered residents a desirable compromise between a crowded metropolis and rural Massachusetts. Predominantly residential, with exquisite Victorian homes dating from the late 1800s, the city has a long-standing tradition of self-sufficiency, with excellent schools and cultural attractions.

However, the city's IT infrastructure had become outdated. To achieve the growth and sustainability necessary for a more promising future, Chief Information Officer Jorge Pazos began to investigate what innovations were possible within IT that could leverage existing technology investments yet find new ways to generate revenue.

Ultimately, Pazos was inspired to create a regional IT center that could deliver value-added services to several towns and cities surrounding Melrose by sharing resources. The new model would decrease costs and accelerate growth, while enabling reinvestment of unused funds in programs for the citizens of Massachusetts.

This case study, written by Pazos and Colby Cousens, technical manager of the city of Melrose, describes how a NetApp® FlexPod® deployment enabled this small Victorian town in Massachusetts to connect 18 sites with a regionalized private cloud that delivers services to more than 300 municipalities. The regional IT blueprint developed by Pazos was prominently featured in the Commonwealth of Massachusetts regionalization plan for IT (www.mass.gov/governor/regional).

Business Context

In the fall of 2009, Melrose's IT department was managing a mix of 20 HP and Dell servers locally and another 25 spread throughout the schools. Each server had its own individual tape-based storage drive. Not only were we running out of space in our server room, but also a tangle of cables was connecting everything together, and power and cooling resources were stressed. Organizational challenges and daily maintenance tasks were overwhelming. For example, we had to physically change tapes and move them off-site to secure our backups.

At the same time, an explosion of interest in technology and demands on IT occurred. The fire department needed mobile data terminals and GPS tracking, and the police launched a crime analysis program with a back-end database and automatic license plate reader that required storing thousands of images. We also had to make room for recording all phone calls to public safety dispatch. Adding more than two dozen security cameras throughout the city required 8TB of disk alone. We weren't confident in the reliability of our communications infrastructure, yet over 30 departments in more than 20 buildings depended on it for daily operations.

We began to focus on five key areas of concern:

- The age and dependability of our switching/link speed between buildings. The switching equipment in place was nearing end of life, and buildings were all connected to it with a coaxial I-NET maintained by Comcast. As a result, our network—and in turn our productivity—was affected by the weather. Without true ownership of the infrastructure, we had to rely on Comcast for diagnosis and repair.
- The rate of increase in our storage demands. A newer generation of

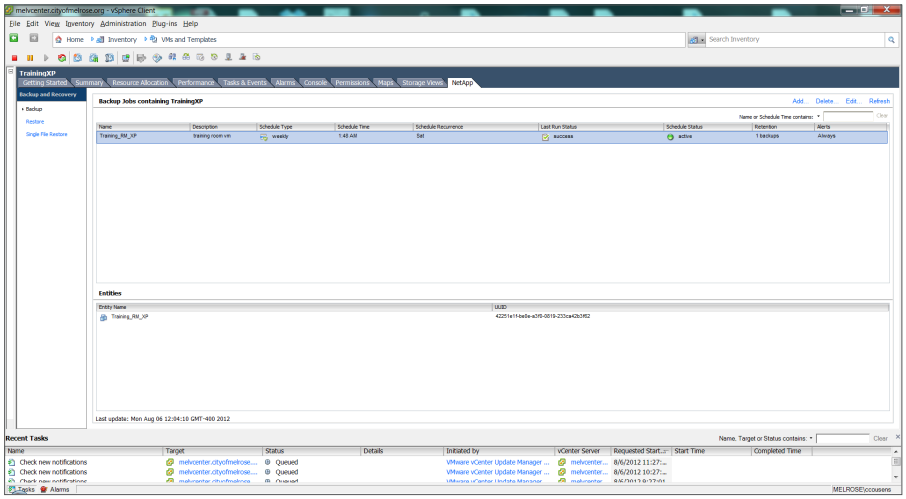

Figure 1) Configuring backups in vSphere with NetApp VSC.

workers brought a strong interest in technology, and a desire to implement numerous products required additional data center resources. Products were sometimes purchased without a full understanding of the costs associated with their deployment. Storage and backups were somewhat dispersed and therefore not entirely reliable, and many of the database applications required a level of performance that was hard to achieve given the resources and funding we could expect on an annual basis.

- Disorganized use of compute resources and support agreements. In a rush to deploy services, some servers became overloaded, while others ran almost idle. The percentage of equipment with four-hour support was not large enough to handle all the critical applications our department was required to manage.
- Duplication of equipment and effort. Technologically, the city's infrastructure was divided into various areas: independent head ends, network cores, storage, and backup between city and school departments. Equipment purchasing, support, and common maintenance tasks were often duplicated, simply because of the way our infrastructure had been laid out over the years.
- No room to expand. As demand for services and support increased, so did the need to house equipment in a secure, central location with network access and adequate power and cooling to protect it. Looking toward the future, it was apparent that the cost of expansion in our facility would become a burden equal to those we already faced with procurement and support of the equipment itself.

Meanwhile, budgets for state and local governments around the country are under a great deal of pressure. As a result, both state and local governments have taken a fairly aggressive approach to squeezing out efficiencies, sharing costs, and regionalizing services. All of those factors prompted us to explore how we could consolidate operations intelligently.

As a first step to creating a workable shared infrastructure, we initiated the development of a private cloud, which provides the flexibility, scalability, and security required to deliver a broad set of services efficiently and cost-effectively.

New Infrastructure

The opportunity arose in Melrose to upgrade the city's network infrastructure; we replaced an aging, unreliable system with high-speed fiber optic links to 33 departments in 23 buildings within a land area of 4.8 square miles. This upgrade allowed us to begin consolidating equipment that was previously duplicated in multiple locations.

We turned to ePlus Technologies for a recommendation on a data center solution allowing us to bring our existing data, equipment, and services more efficiently into a single location. The initial deployment was to fulfill our needs internally and provide a basis for the service of city and school technology requirements but had to scale and support the vision of a municipal cloud that could host the same for any of the surrounding cities and towns in Massachusetts.

The project began with the consolidation of two technology departments between the city and the schools and building in dedicated fiber to connect all of the buildings back to a central core switch. Next, we consolidated the server infrastructure. ePlus introduced us to NetApp FlexPod, a predesigned base configuration built on the Cisco Unified Computing System™ (Cisco UCS®), Cisco Nexus® data center switches, NetApp FAS storage components, and a range of software partners. FlexPod is a baseline configuration, but also has the flexibility to be sized and optimized to accommodate many different use cases. It would allow us to increase capacity rapidly without having to rip and replace expensive equipment down the road.

Figure 2) FAS2040

FlexPod for VMware® is built on the FlexPod infrastructure stack with added VMware components, including VMware vSphere® and vCenter™ for virtualized application workloads.

Compute Environment

A Cisco Nexus 7010 provides core routing at the data center in City Hall. Having all of our links passing through this core NetApp agile data infrastructure provided a pivotal storage resource for segmenting, securing, and deduplicating a diversity of data. This combined with virtualization technology from VMware allowed the city to further reduce operational costs by consolidating compute resources onto Cisco UCS B250 M1 blade servers.

Cisco

The core of our network routes through a Cisco Nexus 7010 with 32 single-mode fiber optic small form-factor pluggables (SFPs) and multiple virtual routing tables to securely segment networking access and keep data center tenants separate. Connections pass directly into their respective tenancies using VLANs or individual physical connections, but no tenant has access to another's resources using the network. Server traffic passes through VLANs on a 10GB link through a data center switch into the Cisco UCS 6120XP fabric interconnect. This device provides all the management and configuration for the Cisco UCS blade server system and is mirrored in a redundant configuration in case of equipment failure. Twinax cabling connects the 6120 to Cisco Nexus 2100 fabric extenders in the Cisco UCS 5100 blade chassis. We currently run two B250 M1 blades with 96GB of RAM apiece and are in the process of installing an additional blade.

VMware

The blade server connects to our storage environment on the back end, and the VMware hypervisor and management software sits on top, allowing us to configure and administer virtual machines. There is a strong integration with both Cisco UCS servers and NetApp storage through the vSphere client. NetApp provides a virtual storage console plug-in for vSphere that allows us to configure backups, mirroring, and alerts very quickly from the same interface, where we perform most daily tasks with virtual servers and desktops (see Figure 1).

The organizational structure of our virtual environment in the vSphere client makes it easy to denote servers, virtual desktops, and infrastructure virtual machines or appliances across multiple tenants and assign management permissions using role-based access. We are currently running close to 40 virtual servers and have deployed about 30 thin clients that access virtual desktops in production out of three active tenants on FlexPod. All of our critical apps run on this system, including Microsoft® SQL Server®, our financial system, Web servers, domain controllers, police dispatch, and Microsoft Exchange 2010. Test environments are not difficult to configure, and we make use of the infrastructure for this purpose as well. We maintain one physical domain controller with all of our essential management tools in case of failure or downtime.

NetApp

Our deployment currently consists of a FAS2040 dual-controller HA configuration with two shelves and a Fibre Channel–connected DS14MK4 and SAS-connected DS4243 for a total of 12TB of space (see Figure 2). Plans exist to add a FAS2240 and cascade the FAS2040 to a disaster recovery location we are in the process of populating to completely support the primary site in the event of failure or service interruption.

Significant storage management is provided through the vSphere client, but NetApp OnCommand® System Manager is a very popular tool in our data center as well. Our shelves are a mix of SAS and SATA disks, and we tier our storage based on performance requirements. CIFS shares sit in an aggregate full of dedicated SATA disks,

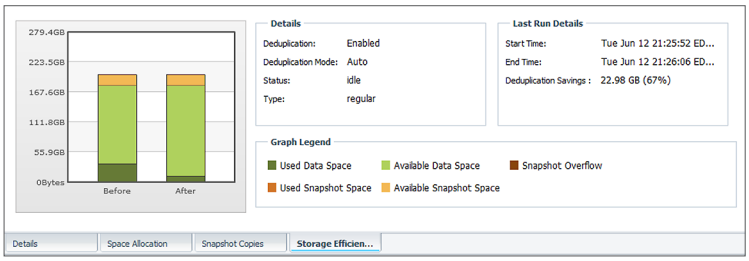

Figure 3) Example dedupe rate on a small virtual machine datastore.

while VMDKs and database LUNs get the higher performance SAS drives. Storage efficiency is extremely valuable, and we use it extensively, observing up to 67% deduplication on virtual machine datastores (see Figure 3).

Thin provisioning adds some breathing room as well, allowing us to overcommit volumes to meet application system requirements and monitor and alert when actual physical size approaches limits. We manage our storage tightly; flexible volumes with autogrow configurations and detailed alerts on abnormal rates of increase allow us this luxury. A system like this really highlights the inefficiencies of storage in a direct-attached scenario (see Figures 4 and 5).

With FlexPod in place, the city of Melrose can act as a managed service provider, delivering IT infrastructure and applications to nearby towns. By regionalizing IT infrastructure, the city of Melrose will save the county a lot of money. The town of Essex, about 25 miles away, has already reduced IT expenditures by about 33%. Melrose has reduced costs by 40% annually.

Implementation Process

Our storage needs were more critical than other parts of the FlexPod design at the time we were considering it. ePlus technologies put our FAS2040 in place right away while we waited for other equipment to arrive. It was helpful to have the freedom to deploy parts of the solution and begin to migrate our environment on a flexible schedule as it aligned with maintenance windows.

Week 1: NetApp FAS2040 Installation

The physical racking and cabling of the hardware and integration of our environment took two days. Another two days were spent configuring software and installing management clients. At this point we began to migrate storage to the iSCSI volumes and CIFS shares.

Weeks 2–3: Cisco Switching

As we implemented FlexPod, we installed our new fiber optic network, replacing all core switching and deploying a number of Cisco® edge solutions to bring buildings onto the new network. ePlus set up multiple VRFs and VLANs on our Cisco Nexus 7010 core router to separate internal network traffic from the traffic generated by the school department.

Weeks 4–6: Cisco UCS Implementation and Training

Installing and getting the Cisco UCS blade server system online took about two weeks. ePlus performed all of the installation and configuration of ESXi™ servers as well as the Cisco UCS service profile creation. Physical-to-virtual (P2V) conversions of our existing servers brought them into the new virtual environment. Technical staff in Melrose participated in the deployment as part of a training program to gain familiarity with the equipment and processes required to manage the system. Cisco provided training credits, and during the third week of deployment, Cisco offered a data center training course focusing on Cisco UCS blade server management. The removal of old servers and cabling significantly decreased data center footprint and power consumption.

Week 7: Training and Familiarity

ePlus stayed on after the deployment to help the technical staff gain familiarity with our new private cloud. Administration of a virtual environment was new here, but participation in the deployment and valuable instruction that followed brought our team up to speed quickly. Nearing two years post-implementation, our staff members are as comfortable with the new infrastructure as they ever were with the legacy infrastructure.

Current Use Cases

With FlexPod in place, the city of Melrose can act as a managed service provider, delivering IT infrastructure and applications to nearby towns. In early October 2011, the city signed its first regional partner, Essex, Massachusetts. By outsourcing its IT services to the city of Melrose, it is anticipated that Essex will reduce IT costs by 33% annually.

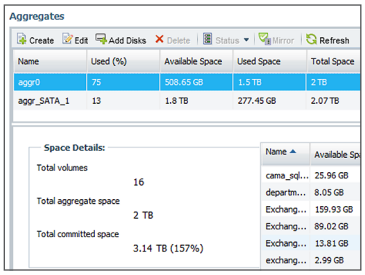

Figure 4) aggr0 157% committed with 25% still available.

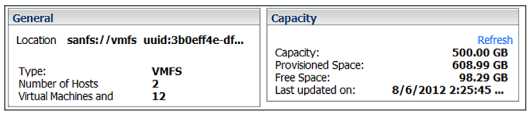

Figure 5) VMFS datastore overprovisioned.

Meanwhile, Melrose has reduced costs by 40% annually.

Following are the current use cases for the FlexPod solution in the city of Melrose and surrounding partners:

Internal Hosting and Services

Our data center hosts all the files and services for roughly 300 internal users. All file storage resides in CIFS shares on the SAN. Virtual machines serve domain services, applications, and database products to all city departments, from engineering to public safety. We manage and deploy virtual machines through the VMware vSphere client and storage using NetApp OnCommand System Manager.

Public-Facing External Resources

Many of the services performed by city employees offer resources for the community's citizens, such as assessing or inspecting data, GIS mapping online, permitting online, recreation program enrollment, Web sites, blogs, and other social media. Those resources are hosted out of our data center and help to provide information, enjoyment, and efficiencies to help members of the community operate comfortably and effectively.

Multi-Tenancy and Municipal Cloud

The FlexPod architecture allows us to provision resources securely and host files and virtual machines for a number of remote locations. The schools in Melrose served as our first multi-tenancy pilot and allowed us to leverage the benefits of internal communication, and the close proximity to test and gain feedback we could apply to future deployments. Our user base consists of about 3,700 students and 1,000 staff members. About 1,300 workstations use the network daily to access resources in our cloud. We have since added a tenancy for the town of Essex, Massachusetts, and currently host both files and virtual servers for the local government of an 8,0000-citizen community. A consolidated infrastructure and economies of scale allow us to reduce IT costs and improve the level of service for all partners involved.

Best Practices

Following are best practices we have learned from our own experience implementing a FlexPod architecture:

- Mix SAS and SATA disk shelves and manage your data according to performance requirements to save cost. Consider Flash Cache or Flash pooling to accelerate read and write times on less expensive disks.
- Build virtual templates. P2V conversions help to quickly migrate your environment onto new infrastructure, but virtual machines deployed from a single template that was developed in a virtual environment achieve much higher deduplication rates.

SOLUTION COMPONENTS

NetApp Products

NetApp FAS storage systems
NetApp Data ONTAP® 8
NetApp Snapshot™
NetApp SnapMirror®
NetApp FlexVol®
NetApp Thin Provisioning
NetApp Deduplication
NetApp MultiStore®
NetApp SnapManager® for Virtual Infrastructure
NetApp Virtual Storage Console 2.0
NetApp FilerView® Management Software
NetApp FlexClone®
NetApp RAID-DP®
NetApp Rapid Cloning Utility
NetApp vFiler®
NetApp Snap Creator™
NetApp DFM
NetApp SnapRestore
NetApp Flash Cache

Protocols

NFS, CIFS

"We are reinventing the way local government does business in the state of Massachusetts. This will enable us to speed the delivery of IT services, generate new revenue streams, and reinvest profit in programs for the citizens of Massachusetts."

Jorge Pazos
Chief Information Officer for City of Melrose

- Maintain a backup physical machine that is accessible remotely and has all of your management tools installed. You should be able to connect to this machine using VPN and investigate any e-mail alerts or other concerns about your virtual infrastructure at any time.

For More Information

Read the business brief:
http://www.netapp.com/us/company/our-story/customer-showcase/city-of-melrose.html

Learn more about city of Melrose:
http://www.cityofmelrose.org

Learn about ePlus:
http://www.eplus.com

Read more about FlexPod:
www.netapp.com/flexpod

Find out how NetApp can help you build a private cloud or buy cloud services:
www.netapp.com/cloud

ABOUT THE AUTHORS

Jorge Pazos
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City of Melrose, Massachusetts

Jorge Pazos is a public sector CIO, with 17 years of experience, interested in emerging technologies and their application in education and government. He is always striving to change the "business as usual" mindset and is recognized as a leading figure in the drive to reduce government expenditures through the effective use of technology.

Pazos has been quoted in numerous industry and business publications, including a CIO Magazine white paper and the Boston Globe. He also speaks at industry conferences, including the METAA/COSN CIO Cloud Conference and GovTech's Digital Government Summit conference.

Colby Cousens
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Colby Cousens has studied Business and Computer Information Sciences at Bentley University and Boston University. He has been involved in a number of startup projects and sits on the board of directors for a small Boston-based corporation. With over eight years of experience in Municipal IT, he has contributed to several online publications, including Cisco Blogs, and regularly pursues testing and pilot opportunities for unreleased and market-leading technology.

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