Microsoft® | Virtualization

NETAPP WHITE PAPER

A Customer Blueprint:
Improving Efficiency and Availability
Using Microsoft Hyper-V and NetApp Storage

Microsoft Solutions Engineering, NetApp
Microsoft Virtualization Solutions, Microsoft

April 2009

EXECUTIVE SUMMARY

This paper presents a customer blueprint based on a typical but fictitious customer to illustrate how a complete end-to-end virtualization solution can address many of the challenges that organizations face today. It includes sample implementation architecture with specific configuration and hardware details to illustrate how a Hyper-V™ and NetApp® solution should be deployed.

TABLE OF CONTENTS

1   INTRODUCTION

You rely on a variety of Microsoft® server applications to run your business, possibly including Microsoft Exchange 2007 for e-mail, SQL Server® 2008 for database applications, and SharePoint® Server 2007 for group collaboration, content management, intranet portals, and more. In many cases these applications not only help your business—they *are* your business.

The benefits of virtualization are primary drivers of modern IT data center infrastructure architecture. Savings are realized in power consumption, hardware utilization, operational efficiency, and the ability to enable higher service levels at a lower cost than legacy environments. Virtualization of infrastructure applications such as DNS and DHCP servers has proven these benefits. Leading-edge enterprises are now extending their virtualized environments to include mission-critical line of business applications such as Microsoft Exchange, SQL Server, and SharePoint.

Server virtualization using Microsoft Windows Server® 2008 Hyper-V enables you to consolidate multiple application workloads on a single physical server, reducing server sprawl and increasing asset utilization. Virtualizing the underlying storage environment enables you to unleash the full power of Hyper-V by providing additional efficiencies that can cut storage, power, cooling, and space requirements by 50% or more without sacrificing performance. In addition to centralized management and rapid server and storage provisioning, virtualization makes it easier to implement effective backup and disaster recovery policies. Combining Hyper-V with NetApp storage allows near-instant backups with no production impact while supporting cost-effective business continuity for your entire virtualized environment rather than just a few mission-critical applications.

NetApp and Microsoft are working together on a number of solutions. This paper presents a customer blueprint based on a typical but fictitious customer to illustrate how a complete end-to-end virtualization solution can address remote site recovery and many of the other challenges that organizations face today. It includes sample implementation architecture, with specific configuration and hardware details, to illustrate how a Hyper-V and NetApp solution is deployed in a real world scenario.

The IT infrastructure described in this white paper was originally designed by the NetApp Microsoft Alliance team and developed into a working, demonstrable system for the annual Microsoft TechEd conference in 2008. Although the company is fictitious, the business and technical requirements are a composite of requirements from real NetApp and Microsoft customers.

2   COMPANY BACKGROUND

Seattle Retail is a fictitious clothing and apparel company headquartered in Seattle, Washington. Seattle Retail has retail stores in four states and long-term plans to expand into three other states. The company employs over 1,500 workers, and until recently expected that number to double over the next 5 years.

The company relies on an existing data center in Seattle, Washington, and has a retail location in Tacoma whose IT infrastructure has room to grow. All monetary transactions route to the Seattle office for processing. Dedicated physical servers support the following applications:

- Microsoft Exchange Server 2007 provides e-mail to users in the company.

- Microsoft SharePoint Server 2007 supports the company's intranet and customer-facing retail Website.

- SQL Server 2008 provides back-end database services for the company's intranet (SharePoint) applications, as well as other business applications.

A long-time Microsoft customer, Seattle Retail is nearing the end of a 4-year technology refresh cycle and plans to upgrade to Microsoft Windows Server 2008.
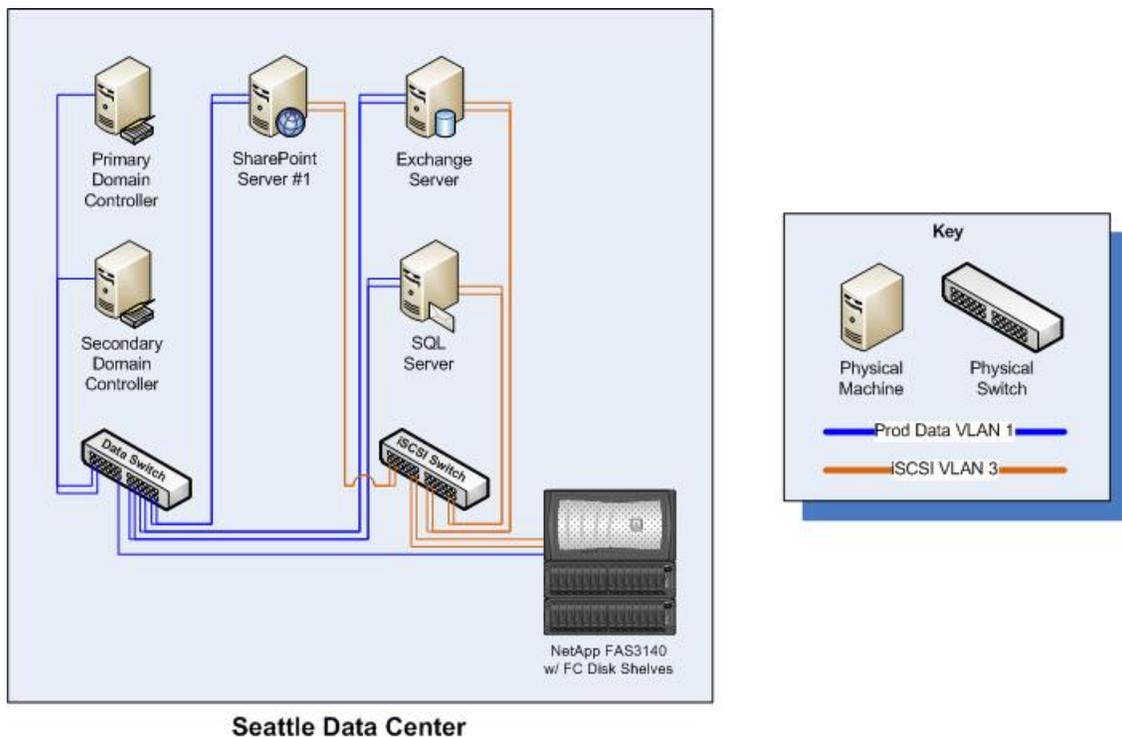
Seattle Data Center

Figure 1) Original Seattle Retail infrastructure (shows only relevant Microsoft applications).

Seattle Retail uses both local and networked storage. A highly available NetApp FAS3140 with 4TB of storage provides file services in its Seattle data center; Microsoft server application data is currently scattered across multiple types of storage. Backups of server application data currently take 8 hours or longer using the built-in Microsoft NTBackup tool. Recovery times are similarly long.

3   CHALLENGES

Like many businesses, Seattle Retail has been affected by a slowing economy. In reaction to worsening economic conditions, the company placed near-term expansion plans on hold and its CEO instructed various departments, including IT, to submit plans to reduce costs and operate more efficiently.

The IT team faces a variety of common challenges, including high capital and administrative costs, underutilized resources, unacceptable application downtime, and a lack of flexibility that makes it impossible to accomplish the transformations that are required to meet ever-changing business demands. All of these challenges increase the cost of ownership year over year.

Two additional challenges have been identified for our fictitious customer. First, administrators are overburdened managing a sprawling, heterogeneous data center. In addition, a recent SQL Server outage in the data center cost the company more than 4 hours of downtime. This outage highlighted the company's lack of preparedness for a system-wide outage, which is especially critical as its online business expands.

For this use case, the following business requirements were established:

- **Decrease overall costs.** Reduce escalating operating costs and achieve a quick payback through reduced operating and administrative costs. The IT team plans to reuse and redeploy existing equipment as possible.

- **Improve recoverability.** Provide faster, more reliable application backups and streamlined recovery for Microsoft Exchange 2007, SharePoint 2007, and SQL Server 2008.

  - Recovery time objective (RTO) must be less than 10 minutes for SQL Server and SharePoint and less than 1 hour for Exchange.
  - Recovery point objective (RPO) can be no more than 1 hour for Exchange and no more than 5 minutes for SharePoint and SQL Server.

- **Add business continuity capabilities.** Eliminate single points of failure by providing high availability for applications running in the Seattle data center as well as site recovery to a secondary data center.

4   PROPOSED SOLUTION

With business requirements defined, the first step for any IT team in planning for future growth is to characterize the performance of existing server and storage components, as well as their interactions. To design a solution, you need to understand the baseline performance characteristics of existing applications. For sites like Seattle Retail, this means focusing on the Microsoft SQL Server, Exchange, and SharePoint workloads in the Seattle data center.

Automated performance logging on each of the relevant application servers for a 5-day business week provides this baseline. Analysis of the logged data enables us to understand the performance characteristics of each application, to help determine the resource requirements (for example, CPU capacity, memory, storage capacity, and storage performance) for each application.

Using the Microsoft Assessment and Planning (MAP) Toolkit, Seattle Retail determined that many of the existing servers were underutilized. The team found anywhere between a 2% and 20% average CPU utilization. The IT team also completed a virtualization assessment to determine how much storage and processing power was needed in their data center and to validate the performance characteristics of various applications. The team then designed a solution that includes:

- Microsoft Windows Server 2008 with Hyper-V server virtualization
- Microsoft System Center Virtual Machine Manager 2008 for centralized management
- Microsoft System Center Operations Manager 2007 to monitor the entire physical and virtual infrastructure
- The existing NetApp FAS3140 and a new FAS3040 storage system to support file services, application data, and Hyper-V virtual machines in Seattle and Tacoma
- NetApp SnapManager® solutions for Exchange, SQL Server, and SharePoint for rapid, consistent backups of applications running either on standalone servers or in virtual machines
- NetApp SnapDrive® to facilitate the creation of crash-consistent backups of Hyper-V child operating systems only
- NetApp SnapMirror® software for data replication to a second data center

These products support a fully virtualized environment including centralized backup, recovery, and disaster recovery.

Server platform. As a SAN-aware OS, Windows Server 2008 serves as the key enterprise storage platform for physical and virtual environments. Windows Server offers world-class SAN support through optimized features for Fibre Channel and iSCSI SANs, including the Microsoft iSCSI Software Initiator, Volume Shadow Copy, and key performance features such as NUMA I/O and MSI-X. Windows Server 2008 includes a number of important high-availability features to help organizations meet their uptime requirements for their critical systems, such as Microsoft MPIO; and Failover Clustering. Windows Server 2008 can help build redundancy into the network and eliminate single points of failure. All of features help reduce downtime, guard against data loss, and reduce total cost of ownership.

Microsoft MPIO maintains application uptime by maintaining connections from Windows Server 2008 Server and enterprise storage arrays even in the event of loss of connectivity or hardware failure. The Microsoft MPIO framework maximizes the performance of Windows® by managing and efficiently using up to 32 paths from storage devices and applications/operating systems over iSCSI and Fibre Channel. Deploying MPIO reduces downtime and guards against data loss, thereby reducing total cost of ownership. The Microsoft MPIO framework offers a pluggable architecture for tight integration with enterprise-class storage arrays.

A Microsoft Windows Server 2008 failover cluster provides redundancy against a server failure by providing high availability during an operating system failure or a planned upgrade. In this case, the failover cluster fails over to any other node in the failover cluster configuration, minimizing system downtime.

Server virtualization. Since Seattle Retail IT already plans to upgrade to Windows Server 2008 as part of its 4-year technology refresh cycle, the Microsoft Hyper-V server virtualization software that ships as part of the operating system is a logical fit. Hyper-V allows server virtualization and consolidation without the purchase of additional virtualization software. It also gives Seattle Retail a single management paradigm (skill set, support model, management console) and provides support for 64-bit guests, following the trend to 64-bit computing in the Microsoft environment.

Microsoft System Center enables management of both the physical and virtual infrastructure from a single console. System Center Operations Manager monitors applications and the physical infrastructure in addition to the storage components. System Center Virtual Machine Manager 2008 centralizes the deployment and management of virtual machines across multiple Hyper-V hosts.

To meet server requirements, the Seattle Retail scenario retains two existing servers to act as physical servers for Exchange and SQL Server. Three existing servers were retired and three new Windows Server 20080 servers will be purchased in their place to support virtualization.

Application and virtualized server storage. The existing NetApp FAS3140 provides application and Hyper-V storage in addition to file services, protecting company data while dramatically simplifying data management tasks, including backup and restore and replication. Redundant paths from each server to the NetApp array are provided by the Microsoft MPIO framework and the NetApp Data ONTAP DSM. This allows bandwidth over multiple adapters to be aggregated, increasing throughput to maximize performance. A NetApp FAS3040 will be purchased for the secondary data center and configured similar to the NetApp FAS3140 at the primary site in Seattle.

In addition, Seattle Retail will be able to considerably reduce the storage footprint of its Hyper-V environment by using NetApp storage efficiency technologies, including:

- **Snapshot™ copies** are the basis of all NetApp data protection technologies. Snapshot backups consume additional space only as changes are made to the underlying volume. This unique approach enables you to create backups in a matter of seconds without affecting your production environment. You can back up your environment more frequently, and you can store more of these highly space-efficient backup copies.

- **RAID-DP®** offers protection against double disk failures. In a Hyper-V environment, any storage system failure can affect dozens to hundreds of business applications. RAID-DP provides much more robust protection than RAID 5, which protects against the failure of only a single disk, at a much lower cost than RAID 10 and with no performance penalty.

- **Deduplication** eliminates duplicate data blocks on disk that result, for example, from copies or variations of the same file. Deduplication is particularly useful in virtual server environments that have multiple copies of nearly identical operating systems and application code, where storage savings can be in excess of 70%. Only NetApp is currently able to reclaim space with deduplication for primary (active) as well as secondary (backup) storage.

- **Thin provisioning** allows the presentation of more storage space to hosts connected to the storage system than has been physically allocated. This approach treats storage as a shared resource pool where space is consumed only as each application requires it. Thin provisioning can save 20% to 30% more storage capacity than traditional provisioning.

Deduplication
Save up to 95%
Saves up to 95% for full backups; 25% to 55% for most data sets

Double Parity RAID (RAID-DP®)
Save Up to 46%
Saves up to 46% versus mirrored data or RAID 10

Thin Provisioning (FlexVol®)
33%
20% to 33% typical savings

Snapshot™ Copies
Save over 80%
NetApp Snapshot copies do not require "copy" space, serve local backup purposes, deliver savings of up to 80%

Figure 2) Overview of NetApp storage efficiency technologies and the savings available using each. Space savings are not cumulative, but efficiencies increase as each new feature is incorporated into the environment.

Application backup. NetApp SnapManager software is available for Microsoft SharePoint Server, Exchange, and SQL Server to simplify backup and other data management functions. The software can be used with applications running on either physical or virtual machines. All SnapManager solutions can be configured with automatic backup policies that protect data according to a defined schedule, with dramatically simplified application recovery. When creating a backup, SnapManager uses the Microsoft Volume Shadow Copy Service (VSS) framework to put the application in hot backup mode, and then a

NetApp Snapshot copy is created in just a few seconds. Because of the speed of these backups, they can be done more often without disrupting operations.

The combination of NetApp SnapManager and NetApp SnapDrive software provides a tightly integrated management solution by leveraging native management interfaces provided in Windows Server 2008 for managing connections to iSCSI and Fibre Channel arrays and allows for administrators to take advantage of VSS with NetApp Snapshot copies.

Virtual machine backup. NetApp SnapDrive can be used to create Snapshot copies of LUNs containing Hyper-V virtual hard drives. SnapDrive first quiesces the NTFS file system, providing crash-consistent backups of child operating systems only.

Business continuity. Given the small footprint of the servers and storage needed in the secondary facility, Seattle Retail will be able to leverage existing air-conditioned space in the network closet of their retail facility in Tacoma to house their secondary environment with few physical changes. All retail sites have network connections to the Seattle data center, so network bandwidth is already in place.

NetApp SnapMirror technology will provide data replication across the WAN to the Tacoma location. By transferring only changed blocks, rather than changed files, SnapMirror makes more efficient use of available network bandwidth than other replication solutions. By applying deduplication on the primary site—particularly to storage used for Hyper-V virtual machines that have nearly identical child operating systems—bandwidth requirements are further reduced.

5   SAMPLE IMPLEMENTATION

The architecture illustrated in Figure 3 implements the key elements of the solution described earlier. This architecture was designed to reduce server count, provide business continuance, and simplify administration in both Seattle and Tacoma.
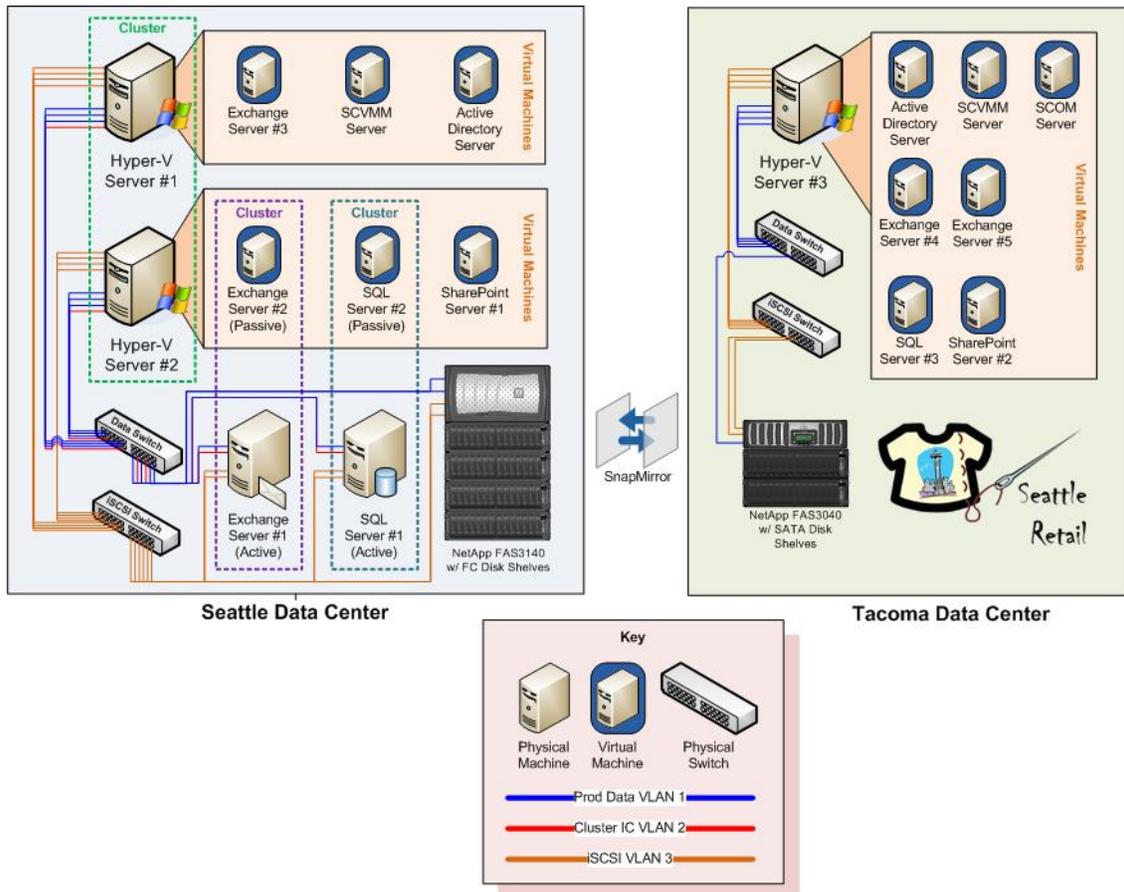

Figure 3) Logical Seattle Retail architecture.

In the primary data center in Seattle, a combination of physical servers and virtualized servers host the e-mail, database, collaboration, Web, and infrastructure servers.

- Microsoft Hyper-V is deployed on two physical servers, configured with eight cores and 16GB of memory, and multiple Intel network adapters. These Hyper-V servers are fully redundant, protected against physical server failure, storage array or path failure, and network failure. This is accomplished through Hyper-V integration with Windows failover clustering for protection against physical server failure, as well as protection against network failure with configuration of redundant network adapters, and protection against storage path failure via NetApp Data ONTAP® DSM integration with Microsoft MPIO.

- Microsoft Exchange is deployed in a cluster continuous replication configuration for HA. The active physical node runs the Mailbox role, and the passive node runs this role in a virtual machine hosted on one of the Hyper-V servers. A third, non-clustered virtual server hosts the Hub Transport and Client Access roles. All Exchange Servers are connected via iSCSI using the Microsoft iSCSI Software Initiator to directly connect to the Exchange data stored on the NetApp FAS3140.

- Microsoft SQL Server is deployed in a two-node failover cluster, with the active node running on the single-purpose physical system. All SQL Servers are connected via iSCSI using the Microsoft iSCSI Software Initiator to directly connect to a shared copy of the SQL databases stored on the NetApp FAS3140. Connecting through the Microsoft iSCSI initiator in the VM provides application transparency and interoperability with SAN management applications as well as access to features such as VSS snapshots and LUN cloning.

- Microsoft SharePoint Server is deployed on a single virtual server, which provides application and collaboration services for the Seattle Retail intranet, as well as hosting the customer-facing retail Website. The SharePoint server is connected via iSCSI using the Microsoft iSCSI Software Initiator to directly connect to the SharePoint data stored on the NetApp FAS3140.

- Microsoft System Center Virtual Machine Manager (SCVMM) 2008 is deployed on a single virtual server, enabling administrators to centrally configure and monitor physical and virtual systems, and migrate VMs between multiple Hyper-V hosts. The SCVMM server at the primary site in Seattle is not configured to be integrated with Microsoft System Center Operations Manager 2007, which is deployed on a single virtual server at the secondary site in Tacoma.

- Virtual machines hosted on the two Hyper-V servers run additional applications that are not CPU and memory intensive, such as the primary domain controller.

The original NetApp FAS3140 storage system stores all operating system files and data for the Hyper-V virtual machines plus Exchange, SQL Server, and SharePoint application data. Consolidating all data on highly reliable and efficient NetApp storage greatly simplifies the storage environment, reduces storage waste, and makes it possible to manage and protect all data by using the same tool set.

NetApp SnapManager software for Microsoft Exchange, SQL Server, and SharePoint is combined with NetApp SnapDrive to help streamline storage management and enable application consistent backups. These tools are tightly integrated with each application to simplify storage layout planning and backup and restore operations. For example, SnapManager facilitates document level recovery in SharePoint environments. All three SnapManager products work with NetApp SnapMirror replication software to simplify data replication to a FAS3040 in Tacoma for business continuity.

To contain costs, asynchronous SnapMirror was used for the initial implementation for the database volumes of each application, which are synchronized every 15 minutes. All other critical data volumes will also be synchronized every 15 to 30 minutes, based on the required RPO for that system. Synchronous SnapMirror was used for log volumes to support the 5-minute RPO for Exchange and SharePoint. If the business climate changes or Seattle Retail's requirements increase, the entire deployment can be upgraded to synchronous SnapMirror with increased bandwidth.

In the secondary data center in Tacoma, only virtual servers are available to assume applications and services after a major failure at the primary data center in Seattle:

- A NetApp FAS3040 storage system with SATA disk provides storage for the Tacoma data center. Because using dissimilar drives and controllers at the disaster recovery site can cause concurrency issues for applications that require high I/O rates, the IT team has set expectations that some applications may see some performance impact in the event of a site failover and therefore has configured some sensitive applications to better handle timeouts. Using less expensive storage enables Seattle Retail to minimize costs while providing adequate performance and data protection for the secondary environment. The ability to create this architecture is a unique NetApp benefit

because, unlike other replication solutions, NetApp SnapMirror can accommodate dissimilar source and target storage systems.

- Microsoft Windows Server 2008 Hyper-V is deployed on a single physical server, configured with 16 cores, 64GB of memory, and multiple Intel network adapters. All applications, whether previously hosted on physical or virtual servers at the primary site in Seattle, fail over to virtual machines.

- Microsoft System Center Operations Manager (SCOM) 2007 is deployed on a single virtual server. This monitoring tool plays a central role in automating the failover from Seattle to Tacoma by monitoring both the physical and virtual server infrastructures as well as the storage infrastructure. It can detect a major failure of multiple infrastructure components and then initiate a failover of all infrastructure components from the Seattle data center to the Tacoma data center. When it detects a major failure, it makes sure that all resources from the Seattle data center are no longer accessible before automating the process to break the storage mirror relationships and make sure that all shared storage components are online. Once the storage components are online, SCOM contacts Microsoft System Center Virtual Machine Manager to power on all other virtual servers in the Tacoma data center.

- Microsoft System Center Virtual Machine Manager (SCVMM) 2008 is deployed on a single virtual server and is integrated with Microsoft System Center Operations Manager (SCOM) 2007 installed on a virtual server in the same site (Tacoma). Therefore, not only can SCVMM manage the physical and virtual systems at the Tacoma data center, it integrates with SCOM to monitor the virtual systems in a more detailed fashion.

   For instance, the integration between SCVMM and SCOM enables Performance and Resource Optimization (PRO), which allows for workload- and application-aware resource optimization. With PRO, the administrator can create policies that SCVMM can act upon to implement "tips" automatically or manually. PRO provides values of minimizing downtime and accelerating resolution of issues; more advanced users can design policies that achieve hands-free management through self-healing infrastructures.

   In addition, because the management and monitoring tools are extended to the physical and virtual machines and all the way to applications running on top of the operating systems, the System Center family provides a complete view of business services from a single pane of glass.

Appendix A describes the NetApp components that are used to implement this hypothetical solution.

6   PROJECTED IMPACT

This scenario shows how a virtualized server and storage environment can address all of the business requirements detailed in section 3.

Increased efficiency and cost reduction. Customers can reduce capital expenditures and operational costs by cutting total server count, reducing server and storage complexity, rationalizing backup and restore capabilities, and creating an easy-to-manage framework for business continuity. Implementations at customers with business problems similar to Seattle Retail have resulted in significant savings from server consolidation, reduced administration costs, efficient use of storage, and improved recoverability:

- In this scenario, two Windows Server 2008 Hyper-V capable servers replace several of Seattle Retail's physical servers. All applications at the Tacoma site run as guests on a single Hyper-V server. The big advantage is the resulting redundancy that the new architecture provides; previously, such redundancy would have required a large increase in physical resources (servers, networking, and so on) and would have resulted in increased complexity as well. Instead, Seattle Retail was able to consolidate from eight physical servers to five, reducing the total number of servers at the sites and associated maintenance, electricity, and cooling costs. Server CPU utilization has increased substantially.

- Consolidating and virtualizing all storage onto NetApp enables an IT team to take full advantage of the benefits of virtualization. Everything is in one place, where it can be monitored and managed by using simple and efficient tools. NetApp SnapManager tools automate application backup, changing what was once an error-prone and time-consuming administrative task into a simple monitoring exercise. Restore is also changed from a frustrating and time-consuming task to a simple chore where a successful outcome is certain.

- It's not uncommon for customers to report a 30% to 40% *overall* reduction in operating costs after virtualization. In fact, NetApp is so confident that its unique RAID-DP, Snapshot, deduplication, and thin provisioning technologies will reduce storage requirements that they guaranteed the Seattle Retail IT team that it would use at least 50% less storage with NetApp compared to traditional storage.[1]

Greater flexibility. End-to-end virtualization enables companies to deploy servers and storage within minutes to support new or existing applications.

- Replacing physical servers with virtual machines dramatically simplifies overall management. Hyper-V guests at both sites can be centrally managed by using System Center Operations Manager and Virtual Machine Manager.

- Storage volumes can grow or shrink—without any interruption to service—to meet changing capacity demands. Data for new applications can be immediately managed by using the familiar NetApp tools for backup, replication, and so on.

Ability to meet RTO and RPO objectives. The Seattle Retail IT team is now confident of their ability to achieve the target RTO and RPO objectives:

- RTO less than 10 minutes for SQL Server and SharePoint and 1 hour for Exchange.
- RPO no more than 1 hour for Exchange and 5 minutes for SharePoint and SQL Server.

Backup and recovery of Windows files, Exchange mailboxes, and SharePoint and SQL Server data sets are all accomplished in minutes with easy-to-use SnapManager tools with the Hyper-V and NetApp environment. This allows multiple daily backups versus the more than 8 hours it took to complete a single backup for the entire original environment, which is based on many real-world environments. In addition to the application data, the Hyper-V virtual machines are also backed up and automatically replicated to the DR site. Restoring an application and the virtual server after a failure is significantly faster than restoring a physical server from bare metal.

Availability and site recovery. This solution provides high availability for critical applications in the primary data center as well as failover to a secondary data center for more serious problems such as a site-wide outage. In the primary data center, the combination of Windows Server 2008 high availability features with NetApp RAID-DP provide a very high degree of reliability. A standalone storage system— also with RAID-DP—provides protection at the secondary site. The NetApp systems may deployed in an active-active configuration in the future, when funds become available, to provide an additional level of protection. The disaster recovery capability designed for Seattle Retail relies on mirroring data from the primary site to the secondary site. NetApp deduplication reduces the amount of data that must be mirrored to reduce bandwidth requirements and network load.

Improved productivity. Increased system availability helps improve the productivity of Seattle Retail employees. The IT staff can manage the streamlined IT infrastructure and no longer has to regularly work weekends and evening. In fact, the IT team even has time to focus on more strategic projects rather than day-to-day production tasks. Additionally, increasing Seattle Retail's Website uptime helps retain customers and enables the business to continue to go further, faster.

---

[1] This guarantee and related Program are limited to the terms set forth in www.netapp.com/guarantee applicable only to prospective orders placed after the Program effective date and are dependent upon your compliance with the terms and conditions set forth in this document and any of the instruction sets and specifications set forth in the referenced documents. NetApp's sole and exclusive liability and your sole and exclusive remedy associated with the terms of this guarantee and related Program is the provision by NetApp of the additional storage capacity as set forth in this guarantee and related Program.

7   CONCLUSION

Although this use case is hypothetical, it demonstrates the potential impact of combining Microsoft Hyper-V virtualization with NetApp storage solutions in a typical Windows application environment.

By using virtualization, Seattle Retail reduced its total number of servers and added another data center for business continuity while keeping new purchases to a minimum. To support this project, Seattle Retail needed to purchase:

- Three multi-core IBM servers capable of supporting large numbers of virtual machines
- A NetApp FAS3040 with 4TB of SATA disk for the secondary data center
- Microsoft Windows Server 2008 (Hyper-V, MPIO, and iSCSI Software Initiator ship as part of the OS)
- Microsoft System Center Virtual Machine Manager 2008
- Microsoft System Center Operations Manager
- NetApp SnapDrive for Windows 6.0
- NetApp SnapManager for Microsoft SQL Server 5.0
- NetApp SnapManager for Microsoft Office SharePoint Server 2.0
- NetApp SnapManager for Microsoft Exchange 5.0
- NetApp SnapMirror software

Three physical servers were retired from service, overall availability was increased dramatically, and the infrastructure was simplified. Backup times were reduced from 8 hours or longer down to minutes, and all backup processes were automated.

The combination of Microsoft Hyper-V and NetApp technologies designed for Seattle Retail provided server and storage consolidation, reduced administration costs, improved recoverability, and full business continuance.

APPENDIX A: PHYSICAL INFRASTRUCTURE

The entire physical infrastructure needed to support the Seattle Retail business services configured within the logical implementation shown in Figure 3 resides in one 47U rack at each of the Seattle and Tacoma data centers.
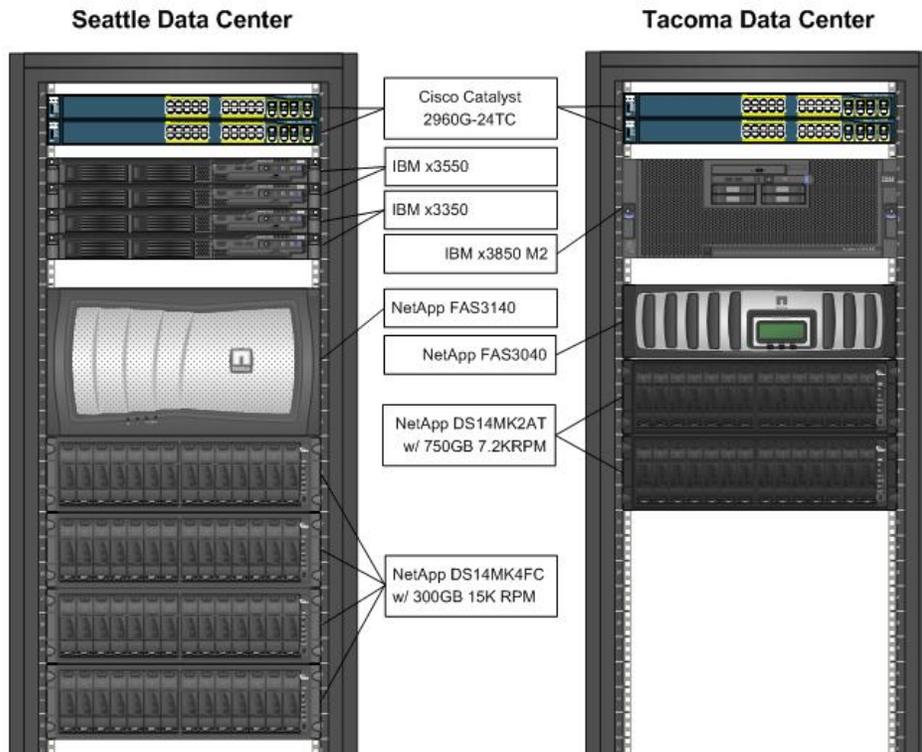
Figure 4) Physical implementation of the Seattle Retail environment.

There are three sets of components in the Seattle Retail environment.

- **Servers.** Four physical servers and seven virtual servers support the primary Seattle data center. One physical server in the business continuity data center in Tacoma hosts eight virtual servers.

  - **Seattle Data Center**
    - **SQL Server.** One IBM x3350 physical server (previously existing in the environment) has Microsoft SQL Server 2008 installed, along with Microsoft MPIO and Windows failover clustering, and is configured as the primary active node in the SQL Server Cluster. This SQL Server Cluster provides the databases supporting Seattle Retail applications, as well as the intranet (SharePoint libraries) and Internet (IIS) applications.
    - **Exchange Server.** Microsoft Exchange is configured in a CCR cluster with the active node running on an IBM x3350 physical server (previously existing in the environment) and the passive node running in a VM on one of the Hyper-V hosts. This Exchange Cluster supports all the messaging and collaboration services for the Seattle Retail environment.
    - **Hyper-V Servers.** Two IBM x3550 physical servers each configured with eight cores and 16GB of memory have Windows Server 2008 Hyper-V installed to support the virtual environment in the Seattle data center. These are configured using Microsoft MPIO and Windows failover clustering to support highly available virtual machines. The Hyper-V server hosts support several key virtual machines in the Seattle server environment:
      - *Active Directory Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft Active Directory®, and is configured as the primary domain controller for the Seattle Retail environment. This server also functions as the primary DNS server for the environment.
      - *SharePoint Servers.* One virtual machine has Windows Server 2008 installed, with Microsoft SharePoint Server 2007, to support the Seattle Retail intranet, as well as host the customer-facing retail Website.
      - *SQL Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft SQL Server 2008, Microsoft MPIO, and Windows failover clustering, and is

configured as the passive node in the SQL Server cluster. This cluster provides the databases supporting Seattle Retail applications, as well as the SharePoint libraries.

- *Exchange Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft Exchange Server 2007, and is configured as the passive node in the Exchange cluster continuous replication configuration. An additional virtual machine is configured with Windows Server 2008 and Microsoft Exchange Server 2007 to run the Hub Transport and Client Access roles.
- *SCVMM Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft System Center Virtual Machine Manager (SCVMM) 2008, and supports management of the virtual systems in the Seattle environment, as well as hosting the library of components used for provisioning virtual machines.

- **Tacoma Data Center**
  - **Hyper-V Server.** One IBM x3850 M2 physical server, configured with 16 cores and 32GB of memory, has Windows Server 2008 Hyper-V installed to support the virtual environment in the Tacoma data center. The Hyper-V server hosts several key virtual machines in the Tacoma server environment:
    - *Active Directory Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft Active Directory, and is configured as the secondary domain controller for the Seattle Retail environment. This server also functions as the secondary DNS server for the environment.
    - *SCOM Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft System Center Operations Manager 2007, and monitors the state of all servers, both physical and virtual, as well as all applications. This server plays a key role in automating the failover process by running preset tasks if any servers or applications are observed to meet several failure conditions, as configured by policy.
    - *SharePoint Servers.* One virtual machine has Windows Server 2008 installed, along with Microsoft SharePoint Server 2007, and is configured as a secondary environment to support the Seattle Retail intranet and Internet if the primary environment is unavailable.
    - *SQL Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft SQL Server 2008, and is configured as a secondary environment to support the databases supporting Seattle Retail applications, as well as the SharePoint libraries, if the primary environment is unavailable.
    - *Exchange Servers.* Two virtual machines have Windows Server 2008 installed, along with Microsoft Exchange Server 2007. One virtual machine is configured to run the Mailbox role and the other runs the Hub Transport and Client Access roles. Together they form a secondary environment to support the messaging and collaboration services for the Seattle Retail environment if the primary environment is unavailable.
    - *SCVMM Server.* One virtual machine has Windows Server 2008 installed, along with Microsoft System Center Virtual Machine Manager 2008, and is configured as a secondary environment to support the virtual systems in the Tacoma data center if the primary environment is unavailable.

- **Storage.** A NetApp FAS3140 (active-passive HA configuration) provides the storage for the Seattle data center and a FAS3040 provides it for Tacoma.

- **Storage disk shelves.** Four shelves with Fibre Channel drives (300 GB), plus two shelves with SATA drives (500GB), for a total of 41 LUNS, 22 volumes, and about 16TB total. This storage is primarily provisioned for virtual guests, but it is also used by physical servers. Microsoft SQL Server and Exchange Server have dedicated LUNs for databases, log files, and so on.

The contents of the racks in Seattle and Tacoma are as follows:

- Seattle Data Center rack:
  - Two physical servers configured as the Hyper-V host (2U each, total of 4U)
  - One physical server configured as the primary (active) node of the Exchange CCR cluster (2U)
  - One physical server configured as the primary (active) node of the SQL Server cluster (2U)
  - One NetApp storage system (8U)
  - Four NetApp disk shelves (4U each, total of 16U)
  - Two Cisco network switches (1U each, total of 2U)

- Tacoma Data Center rack:
  - One physical server configured as the Hyper-V host (4U)
  - One NetApp storage controller (4U)
  - Two NetApp disk shelves (4U each, total of 2U)
  - Two Cisco network switches (1U each, total of 2U)

APPENDIX B: ACKNOWLEDGEMENTS AND REFERENCES

ACKNOWLEDGEMENTS

The following people were party to the authoring of this document and NetApp would like to thank them for their contributions:

- **Friea Berg**, Solutions Marketing Manager, NetApp
- **Paul Harwood**, Reference Architect, NetApp
- **Chaffie McKenna**, Reference Architect, NetApp
- **John Parker**, Reference Architect, NetApp
- **Brad Garvey**, Reference Architect, NetApp
- **Robert Quimbey**, Reference Architect, NetApp
- **Lee Gates**, Senior Manager of Microsoft Solutions Engineering, NetApp
- **Jim Schwartz,** Virtualization Solutions Marketing Director, Microsoft
- **Suzanne Morgan,** Senior Program Manager Lead, Storage Networking Interconnects, Windows Core OS, Microsoft

REFERENCES

- **Virtualization and Consolidation with Hyper-V**
  http://www.microsoft.com/windowsserver2008/en/us/virtualization-consolidation.aspx
- **Microsoft System Center Virtual Machine Manager 2008**
  http://www.microsoft.com/systemcenter/virtualmachinemanager/en/us/default.aspx
- **Microsoft KB952627**
  32-bit: http://www.microsoft.com/downloads/details.aspx?familyid=BF909242-2125-4D06-A968-C8A3D75FF2AA&displaylang=en
  64-bit: http://www.microsoft.com/downloads/details.aspx?familyid=88208468-0AD6-47DE-8580-085CBA42C0C2&displaylang=en
- **NetApp RAID-DP: Dual-Parity RAID 6 Protection without Compromise**
  http://media.netapp.com/documents/netapp-raid-dp.pdf
- **NetApp and Microsoft Virtualization: Making Integrated Server/Storage Virtualization a Reality**
  http://www.netapp.com/us/library/technical-reports/tr-3701.html
- **NetApp Storage Best Practices for Microsoft Virtualization**
  http://www.netapp.com/us/library/technical-reports/tr-3702.html
- **Microsoft Hyper-V on NetApp Deployment Guide**
  http://www.netapp.com/us/library/technical-reports/tr-3733.html
- **NetApp RAID-DP: Dual-Parity RAID 6 Protection without Compromise**
  http://media.netapp.com/documents/netapp-raid-dp.pdf
- **iSCSI 10GB Ethernet Performance Tuning with Windows Server 2008, Hyper-V and NetApp FAS3070**
  http://download.microsoft.com/download/c/b/6/cb61ca55-30cb-4474-aeb9-2990987c2e73/MSFT-Netapp-10G.docx
- **NetApp Thin Provisioning: Better for Business**
  http://media.netapp.com/documents/wp-thin-provisioning.pdf
- **NetApp FlexClone Volumes: A Thorough Introduction**
  http://www.netapp.com/us/library/technical-reports/tr-3347.html
- **NetApp Virtualization Guarantee**
  http://www.netapp.com/guarantee
- **NetApp Deduplication**
  http://www.netapp.com/us/products/platform-os/dedupe.html
- **NetApp Snapshot Technology**
  http://media.netapp.com/documents/snapshot-brochure.pdf
- **NetApp SnapMirror Technology**
  http://media.netapp.com/documents/snapmirror.pdf

ABOUT MICROSOFT VIRTUALIZATION SOLUTIONS

Microsoft provides a complete suite of technologies to enable an integrated, end-to-end, virtualized infrastructure. Using products that span the desktop to the data center, Microsoft technologies bring capacities online in real time, as needed; streamline and provision applications, services, and data on demand; accelerate backup and recovery; and enhance availability to protect against system failure and service interruptions. Microsoft's extensive partner ecosystem complements and extends the Microsoft virtualization toolset with products for desktops, servers, applications, storage, and networks. Together with our partners, we deliver the most robust, complete solutions for the virtualized infrastructure. For more information about Microsoft Joint Virtualization Solutions, visit http://www.microsoft.com/virtualization/partners.mspx.