
Microsoft® | Virtualization

Increasing IT Efficiency in a Dynamic Datacenter with a Virtualized Storage Solution

End to End Efficiency Delivered by Microsoft Server Virtualization and Compellent Storage Virtualization

Solution Blueprint

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Abstract: This white paper provides a blueprint for a highly efficient and dynamic datacenter using Microsoft® and Compellent technologies. The solution is enabled by Microsoft Virtualization and the Compellent® Storage Center SAN™ solution.

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Executive Summary

Server virtualization has become the cornerstone technology used to increase efficiencies and add dynamic capabilities to the datacenter. Complemented with storage virtualization, the efficiencies can be increased even more dramatically. Together, they are the key to a highly efficient and dynamic datacenter. This white paper provides a blueprint for a highly efficient and dynamic datacenter enabled by using Microsoft virtualization and the Compellent® Storage Center™ SAN solution.

Microsoft virtualization is an end-to-end strategy that can profoundly affect nearly every aspect of the IT infrastructure management lifecycle. It can drive greater efficiencies, flexibility, and cost effectiveness throughout an organization. Adding the Compellent Storage Center SAN solution to a Microsoft virtualized environment helps to efficiently manage the data lifecycle, automatically improve storage use, and increase server performance. Compellent's advanced storage virtualization is integrated with Hyper-V™ and Windows PowerShell™. This integration amplifies the benefits of server virtualization and reduces management overhead.

The Compellent Storage Center SAN solution is built on an advanced virtualization engine that creates a smart, shared pool of storage resources. It uses Fluid Data architecture that enables the Compellent SAN to actively manage data at a more granular level. This Fluid Data architecture significantly lowers storage infrastructure costs, reduces power and cooling costs by up to 93 percent¹, and recovers any size volume to any server in seconds.

A comprehensive virtualization strategy truly has the power to transform the IT infrastructure. Virtualization can be used to accelerate application deployments and ensure the availability of the system, application, and data. In addition, a good virtualization strategy can simplify server and desktop shutdown and rebuilding for testing and development. These virtualization capabilities reduce risk, cut costs, and improve the agility of the entire IT environment.

The key benefits that an enterprise can attain when deploying the blueprint provided in this paper include:

- Hardware cost reduction
- Server utilization improvement
- Energy and space requirement reduction
- Server availability increase
- Application performance improvement

The Compellent SAN virtualization strategy significantly lowers storage infrastructure costs, reduces power and cooling costs by up to 93 percent, and recovers any size volume to any server

¹ See Compellent's white paper "Compellents's Green Advantage – Extending the Life of Data Centers with an Energy-Efficient SAN", November 2007 at: http://www.compellent.com/~media/www/Files/White_Papers/CML_Green_RR.ashx

- Server provisioning and management overhead reduction
- New service rollout acceleration

This paper is written for those who have a working knowledge of Microsoft® Windows Server® 2008 R2 and virtualized Windows Server environments. This paper also assumes that the reader has a basic understanding of storage virtualization, replication, and clustering terminology.

Introduction

Datacenter efficiency is a large concern for Information Technology (IT) management as demands for services continue to increase while budgets continue to be reduced. Supporting growth and maintaining availability per the service level agreements while mitigating the risks to critical data, systems, applications, and the computing infrastructure in the event of a system outage or a complete disaster presents an ongoing challenge from both a technological and a business perspective. Organizations must consistently find solutions that not only meet application and data requirements for capacity, performance, and availability, but also have proven return on investment and cost reduction capabilities.

The approach that companies traditionally take to address this issue is to provide a separate server and storage for each application. For critical applications, this strategy can require multiple servers for redundancy or scaling. Unfortunately, this approach dramatically increases the footprint that the IT department must manage. Large footprints require large IT staffs and more energy to maintain. In addition, rent and hardware costs skyrocket while licensing becomes much less efficient. When launching a new application in this scenario, spec development, software purchase and installation as well as new server preparation can easily take over a month to accomplish.

The growing number of servers significantly hinders standardization and requires a continuously increasing spare part inventory. With each application and hosting server standing on its own, different tools are often required for each. This makes overall management, automation, and reporting very difficult. In order to service a system, downtime must be scheduled. This requires IT to take the system down manually which reduces system availability. This is required for every system update or hardware change.

In addition, because of rising power bills, cooling problems, usage limits imposed by local utilities, or requirements to deploy additional servers without expanding an existing datacenter or building a new one, energy efficiency is a top concern for IT managers. To address energy efficiency, IT managers must look at a variety of issues ranging from the smallest piece of silicon to the entire datacenter. To effectively address the increasing datacenter efficiency concerns, many companies have chosen to virtualize their environments.

Virtualization has been a game changer for many companies. It has enabled companies that previously were unable to afford to deploy dynamic capabilities into the datacenter to begin implementing these efficient solutions.

Key Concepts

The basis of this blueprint is the virtualization of the datacenter. In order to successfully apply this blueprint, a basic understanding of the virtualization concepts and storage efficiency technologies is necessary.

Virtualization

Server virtualization is a hot trend in the IT world because of the many business and technical benefits it can provide over the near and long term. There are many types of virtualization strategies that can be utilized in the datacenter, but for the purpose of this paper, the focus is on server virtualization, the storage platform for server virtualization, and storage virtualization.

Server Virtualization

By enabling organizations to run multiple operating systems and applications on a single physical server versus multiple physical machines, server virtualization can help organizations reduce hardware, energy, and management overhead significantly. Server virtualization is also a key building block of a dynamic IT infrastructure which is all about efficiency, resiliency, and agility.

From an application perspective, server virtualization enables organizations to consolidate workloads. This increases resource utilization and lowers capital and operational costs. In addition, server virtualization can help organizations improve application performance, availability, management, and agility. The more agile the IT environment is, the more an organization is able to meet changing business and application requirements.

Storage Platform for Server Virtualization

The type of storage platform that organizations deploy to support a virtualized server environment is very important. For example, in advanced scenarios that take full advantage of the availability and flexibility of virtualization, external shared storage is required. In addition, the right storage system platform should ensure low latency for maximum performance, provide scalable capacity and bandwidth as application demands change, and automatically balance application workloads as needed.

To support the dynamic Hyper-V virtualized environment, the storage platform must make it easy to create, size, and move storage volumes as required. Also, because server consolidation through virtualization places multiple applications on a single server, high availability features become increasingly important for both the servers and the shared storage. Finally, the right storage platform should also give organizations the ability to virtualize their storage environments by pooling the disk resources required to optimize and protect the application environment.

Virtualization has been a game changer for many companies. It has allowed companies that previously were unable to afford to deploy dynamic capabilities into the datacenter to begin implementing these

Note: *Storage platform for server virtualization is different than storage virtualization. Storage platform for server virtualization refers to externally shared storage that is optimized to better serve a virtualized server environment. Storage virtualization, on the other hand, refers to the process of abstracting logical storage from physical storage. This abstraction process provides numerous advantages and capabilities such as thin provisioning or dynamic snapshots that are not available to storage that is not virtualized.*

Storage Virtualization

By abstracting the logical storage from the physical storage, the dynamic datacenter gains many advantages including the ability to migrate data while maintaining concurrent user access. Utilization can also be increased using thin provisioning services that eliminate allocated, but unused capacity. This enables administrators to allocate any size virtual volume upfront, but only consume the actual physical capacity when the data is written by the application. Also with storage virtualization, there are fewer points of management. The multiple independent storage devices that might be scattered over a network appear to be a single consolidated storage device that can be managed centrally.

Storage Efficiencies

The Compellent Storage Center SAN solution uses some unique technologies that require further explanation in order for the reader to understand the efficiencies gained.

Dynamic Block Architecture

Using Compellent's Dynamic Block Architecture, Storage Center intelligently optimizes data movement and access at the block level. Dynamic Block Architecture records and tracks specific information for almost every block of data so that the SAN knows how each block is being used. This metadata enables Compellent to more intelligently store, recover, and manage the data. This architecture delivers built-in intelligence and automation that optimize the provisioning, placement, and data protection.

Automated Tiered Storage

Compellent provides the only SAN that intelligently classifies and migrates data at the block-level to the optimal tier. Automated Tiered Storage with Fast Track dynamically places the most frequently used data on the fastest, or outer, tracks of each drive. This technology creates a system that requires fewer drives to manage existing data creating big benefits in terms of cost savings, management, and power consumption without sacrificing performance. The result is that the storage is automatically in tune with the application needs. Using Automated Tiered Storage with solid-state drives can reduce both storage costs and administration time while optimizing performance and utilization.

Using Automated Tiered Storage also reduces overall storage costs up to 80 percent by storing inactive data on lower cost SATA or serial attached SCSI (SAS) drives. This lowers drive counts and significantly lowers power and cooling costs. The built-in intelligence eliminates manual data classification and migration, and can be implemented in a few minutes with automatic drive recognition and installation. The savings over traditional storage systems can be showcased using the boardroom-ready Hero Reports provided by Compellent Enterprise Manager software.

Thin Provisioning

With traditional storage systems, administrators must purchase, allocate and manage capacity upfront, all while speculating where to place storage resources and create large, underutilized volumes with long term growth built in. This practice leaves the majority of disk space allocated yet unused, and only available to specific applications.

Compellent's thin provisioning technology, called Dynamic Capacity™, delivers the highest storage utilization possible by eliminating allocated but unused capacity. Dynamic Capacity completely separates storage allocation from utilization, enabling users to allocate any size virtual volume upfront, yet only consume actual physical capacity when the data is written by the application. And, with Compellent's Thin Import and Free Space Recovery, the benefits of Dynamic Capacity can be extended to convert legacy volumes into thin provisioned data or to optimize space utilization in Windows® environments.

Dynamic Datacenter Components

A highly efficient and dynamic datacenter can be created by combining Microsoft and Compellent technologies. This section discusses the relevant technologies required.

Microsoft Technologies

Microsoft virtualization is an end-to-end strategy that can profoundly affect nearly every aspect of the IT infrastructure management lifecycle. It can drive greater efficiencies, flexibility, and cost effectiveness throughout an organization.

A standard Microsoft virtualization implementation is typically structured using the Windows Server 2008 R2 Hyper-V role to enable virtualization and Windows Clustering to handle high availability and disaster recovery requirements. System Center Virtual Machine Manager (SCVMM) is typically used to simplify virtualization management.

Windows Server 2008 R2 Hyper-V

Hyper-V is the hypervisor-based virtualization technology from Microsoft that is integrated into all Windows Server 2008 R2 operating systems. As a virtualization solution, Hyper-V enables users to take maximum advantage of the server hardware by providing the capability to run multiple operating systems (in virtual machines) on a single physical server.

The availability of Hyper-V as a role in a mainstream Windows operating system provides several key advantages:

Features	Benefits
Built in technology	Enables enterprises to easily leverage virtualization benefits without adopting a new technology.
Broad device driver support	The new 64-bit micro-kernelized hypervisor architecture leverages the broad device driver support in the Windows Server 2008 R2 parent partition to extend support to a broad array of servers, storage, and devices.
SMP support	Supports Symmetric Multiprocessors (SMP) in virtual machines (VM).
Host high availability	Windows Server Failover Cluster provides high availability to VMs to minimize unplanned downtime.
Shared storage high availability	Microsoft MPIO dynamically routes input/output (I/O) to the best path and protects against connection failures at any point between a Hyper-V host and shared storage including NICs/adapters, switches, or array ports.
Easy VM migration	Provides live migration capability to support business continuity during planned and unplanned downtime and over distances.
Volume Shadow Copy Service (VSS) support	Robust host-based VM backup is enabled by leveraging the existing Windows VSS-based infrastructure.
Easy extensibility	Easy extensibility is provided using the standards-based Windows Management Instrumentation (WMI) interfaces and APIs.
Simplified integrated management	Due to tight integration into the Microsoft System Center family of products, customers have end-to-end physical and virtual infrastructure management capability for Hyper-V environments.

Table 1: Hyper-V features

Windows Server Failover Clustering

Failover clustering in Windows Server 2008 R2 helps to ensure that mission-critical applications and services, such as e-mail and line-of-business applications, are available when required. Some important capabilities of WSFC for high availability and disaster recovery include:

Features	Benefits
No single subnet limitation	Enables cluster nodes to communicate across network routers. Connecting nodes with VLANs is no longer required.
Configurable heartbeat timeouts	Heartbeat timeouts are configurable to extend geographically dispersed clusters over greater distances. Decrease heartbeat timeouts to detect failures faster and take recovery actions for quicker failover.
Common toolset	Provides a similar management experience to managing a local cluster.
Automated failover	Provides an automatic failover if a complete disaster occurs in one site.
VSS support	Provides VSS support to back cluster settings.
Automation support	Provides automation support for Windows 2008 R2 with PowerShell.
Cross-site replication tool compatibility	Provides mirrored storage between stretched locations in addition to seamless integration with partner hardware or software-based data replication solutions.

Table 2. Windows Server Failover Clustering features

System Center Virtual Machine Manager

Microsoft System Center Virtual Machine Manager (SCVMM) 2008 R2 is enterprise-class management software that enables administrators to easily and effectively manage both physical and virtual environments from a single management console. This software helps to reduce the complexity and the time required to use multiple consoles typically associated with managing an IT infrastructure. The key capabilities of SCVMM 2008 R2 include:

Features	Benefits
Enterprise-class management suite	Manages both Hyper-V and VMware ESX virtualization environments.
Intelligent VM placement	Provides support for the intelligent placement of VMs.
System Center Operations Manager 2007 Integration	Integrates with System Center Operations Manager 2007 to provide the ability to proactively manage both virtual and physical environments through a single console by leveraging PRO.
Native P2V/V2V Migration	Provides native capability for

	physical-to-virtual migrations and virtual-to-virtual migrations.
Failover integration	Integrates with Failover Clustering to support high availability and the live migration of VMs.
Automation	Provides easy automation capabilities leveraging Windows PowerShell.
Quick storage migration	Provides the ability to migrate running VMs from hosts with local disks to hosts with high availability and failover cluster configurations, and then back as needed using the Save State functionality to minimize downtime.

Table 3. System Center Virtual Machine Manager features

Compellent Technologies

Compellent is a leading provider of enterprise-class network storage solutions for dynamic data needs. Compellent's dynamic data technology is called Fluid Data Storage which is the basis of the Compellent Storage Center solution.

The Storage Center solution is a powerful data movement engine with intelligent software application features. It supports an open hardware platform providing a fluid data storage solution. Enabled by dynamic architecture, Fluid Data Storage actively and intelligently manages data at a granular level to cut cost, time, and risk.

The intelligent software further places enterprise virtualized storage capabilities within reach of any organization, regardless of the scale of the implementation. The powerful suite of applications optimizes utilization, automates tiered storage, simplifies replication, provides storage management efficiency, and accelerates data recovery.

Compellent Storage Center SAN solution

The Compellent Storage Center SAN outshines other storage solutions because it provides:

- Unique architecture that manages the data inside the volume.
- Scalable hardware that eliminates the need for a forklift upgrade.
- Powerful software that optimizes utilization, automates replication, and accelerates data recovery.
- Core system technology with essential storage features that are traditionally considered to be add-ons.
- A single interface that manages the entire solution.

In addition, Compellent technologies also provide the following benefits:

- Significant storage cost reduction and equipment life extension.

- 50 percent storage management time reduction as reported by Compellent customers.
- Continuous data availability.
- 93 percent automatic power and cooling cost reduction².

Compellent Storage Virtualization

Compellent is built on an advanced virtualization engine that creates a shared pool of storage resources. Administrators can change, shift, or dynamically scale this virtualized pool without disruption. The system processes multiple requests in parallel to improve system performance and utilization. This shared pool of resources eliminates the guesswork of capacity planning and simplifies storage provisioning for any number of servers. In fact, administrators can quickly and easily create hundreds of virtual volumes to support any Windows Server 2008 R2 with Hyper-V platform and optimize the placement of virtual applications without wasting time, money, or disk space.

The benefits of moving to a Compellent virtualized storage solution include the following:

- **Purchase only needed storage:** Modular hardware architecture and advanced thin provisioning capabilities enable companies to scale performance and capacity for Windows applications incrementally as needed.
- **Recover at the block level:** Compellent's Data Instant Replay enables SQL Server®, Exchange Server, and Hyper-V users to recover data in seconds.
- **Backup without causing a backlog:** Take replays of Windows-based server volumes without taking applications offline. Use Replay Manager and Data Instant Replay with VSS to ensure consistent Windows data even if the server application is running.
- **Simplify storage management:** Automated Tiered Storage tracks blocks inside the volume and migrates inactive data to less expensive storage. In Exchange, this means more mailboxes are provided for less money. Compellent's Dynamic Block Architecture enables program-based storage provisioning and management with Virtual Disk Service.
- **Reclaim storage space:** Uncover important information in the data center by recycling data blocks of information deleted at the file level using Compellent's Free Space Recovery.
- **Increase system uptime:** Keep critical applications online with fault-tolerant server connectivity using Multi-Path I/O. Recover quickly in SQL Server, Exchange, and Hyper-V environments using Volume Shadow Copy Service.
- **Maximize application performance:** Match storage performance to individual program I/O needs using Compellent's Fast Track Technology. Increase critical SQL Server application performance with Fast Track. Fast Track reserves the fastest portion of each drive for the most frequently used data, such as log files.

² See Compellent's white paper "Compellent's Green Advantage – Extending the Life of Data Centers with an Energy-Efficient SAN", November 2007 at: http://www.compellent.com/~/media/www/Files/White_Papers/CML_Green_RR.ashx

Hyper-V Integration

Compellent's advanced storage virtualization is the perfect complement to Hyper-V servers, enabling companies to amplify the benefits of server virtualization from the datacenter to the desktop. The benefits of combining advanced storage virtualization from Compellent with Microsoft server virtualization include:

Easy deployment and Hyper-V server management

- **Small footprint, big impact:** Automatic LUN masking simplifies storage provisioning for any number of virtual servers. Thin provisioning minimizes capacity planning and maximizes disk utilization. Storage virtualization shrinks the data center without sacrificing performance.
- **Server management revolution:** Easily deploy Hyper-V servers with a six-click "Boot from SAN" wizard. Test patches and roll out multiple virtual servers in minutes.
- **Virtual process automation:** Leverage PowerShell functions to further automate backend storage functions and bring new levels of customization to the data center.

Increase availability, not cost or complexity

- **Backup without a backlog:** Implement unlimited server volume replays without taking applications offline using the Replay Manager intelligent snapshot coordinator with Windows technologies. Dynamically add or change storage attributes without impacting applications.
- **Replicate more and spend less:** Space efficient thin replication and block level architecture enable companies to affordably adopt replication for more virtual servers and leverage low cost IP lines.
- **Rapid set up and recovery:** Six-click replication set up requires no advanced training or staff. Predefine recovery volumes, boot remote Hyper-V servers from the SAN or recover any volume to any server within minutes.

Reduce energy costs up to 93 percent

- **Purchase, power and cool only the storage required:** Modular architecture scales as companies grow, maximizing disk utilization and minimizing energy consumption.
- **Decrease disk count and increase performance:** Automated tiered storage intelligently places blocks of data on the ideal disk tier to reduce the need for high powered drives and free up high performance spindles for the most demanding virtual applications.
- **Extend equipment life:** Increased efficiency maximizes current resources reducing upgrades to power and cooling systems and delaying facility expansions.

Storage Center Command Set for Microsoft Windows PowerShell

Compellent Technologies Storage Center Command Set for Microsoft Windows PowerShell is designed to automate the management and recovery of Compellent data storage and Windows enterprise environments including Windows Server 2008 R2

Hyper-V platforms. Compellent is one of the first SAN vendors to integrate Windows PowerShell.

Combining PowerShell scripting with the efficiency of virtualized storage enhances and simplifies server and storage management. For example, an enterprise deploying 50 new servers typically must image all the servers, provision storage volumes, create new user accounts and configure snapshots for backup and recovery. This process can be highly repetitive and manual. With Compellent's Command Set, administrators can create scripts with PowerShell commands to automate all the steps required to significantly reduce time and effort.

Virtualized versus Physical Datacenter Study

Moving from a physical to a virtual datacenter infrastructure has many advantages that have been discussed earlier in this paper. However, in order to understand the overall advantage of this move, this section provides the design for a virtual and a non-virtual Microsoft small business environment for comparison.

The designs for both scenarios are based on industry best practices, Microsoft guidance, and deployment calculators. However, the important point is that both the virtual and non-virtual infrastructures are designed to support the same small business environment. The basic system design for a 500 user small business environment is provided in the following table.

Environment	Non Virtualized			Virtualized
Server	ProLiant DL360 G6	ProLiant DL370 G6	ProLiant DL580 G5	ProLiant DL580 G5
Exchange Mailbox		2		Pooled
Exchange CAS/Hub Transport	2			Pooled
Active Directory	3			Pooled
Web/SharePoint	6			Pooled
CRM	2			Pooled
SQL Server			2	Pooled
Backup		1		Pooled
File Servers		2		Pooled
Forefront	2			Pooled
Development/Test	2	2		Pooled
Total physical servers	26			3

Table 4. Small business environment with 500 user server count

To simplify the comparison, three HP ProLiant servers, the DL360 G6, DL370 G6, and the DL580 G5 were selected so that the pricing could be easily verified and readers could substitute their own infrastructure requirements and pricing. This selection was made for simplification and should not be considered an exclusive endorsement of HP equipment. There are two configurations of the ProLiant DL 580, a virtualized and a non virtualized configuration that are significantly different. The configuration and characteristics of these servers are provided in the following table.

Environment	Non Virtualized			Virtualized	
Server/SAN	ProLiant DL360 G6	ProLiant DL370 G6	ProLiant DL580 G5	ProLiant DL580 G5	Compellent Storage Center
Rack "U"	1	4	4	4	10
Hourly watts	154	394	324	591	1322
Hourly BTU	525	1342	1104	2015	4466
Disk total	3	12	6	4	24
Disk type	146GB 10K SAS	300GB 10K SAS	146GB 15K SAS	146GB 15K SAS	12 x 450GB 15K SAS 12 x 1TB 7.2K SAS
Memory (GB)	4	8	16	96	
Processor cores	4	8	4	16	
Hardware cost	\$6,831	\$13,300	\$17,556	\$37,394	\$123,079
OS cost	\$2,444	\$2,444	\$2,444	\$7,310	
OS edition	Enterprise	Enterprise	Enterprise	Datacenter	
Server total	17	7	2	3	1
Total hardware cost	\$307,883			\$257,191	

Table 5. Virtual and non virtual environment equipment configuration

Infrastructure Comparison

The system as summarized in the previous table supports a typical small business environment with 500 users. This system includes Microsoft Exchange, Web and

SharePoint® servers, Microsoft Dynamics CRM, Microsoft SQL Server, backup, file servers, Microsoft Forefront®, and a development or test environment. It is designed with clustered servers for high availability that require an additional redundant physical server each in the case of the non-virtual environment. Because an advanced virtualized infrastructure requires shared storage, a Compellent Storage Center SAN was added to that environment.

Even though the two infrastructures support the exact same small business environment, they are very different from each other as shown in the following table. While the number of physical servers was reduced by 88.5 percent in the virtual environment, they were replaced with more powerful servers to handle the load. In addition, the virtual environment is much more memory intensive as it requires an 84.6 percent increase in RAM while the CPU memory requirement is reduced in the virtual environment by 60 percent.

	Non virtual	Virtual	Change
Physical cost:			
Physical servers	26	3	-88.5%
Required rack "U"	53	22 Including SAN	-58.5%
Disk total	147	36	-75.5%
Memory total	156	288	84.6%
CPU total	120	48	-60.0%
Hardware cost without OS	\$244,339	\$235,261 Including SAN	-3.7%
Daily power usage:			
Hourly watts used	6024	3095	-48.6%
Hourly BTUs used	20527	10511	-48.9%
Annual electric bill at \$0.11 cost per KW	\$13,061	\$6,710	-48.6%
Licensing:			
OS cost	\$63,544	\$21,930	-65.5%
Overall cost:			
Year 1	\$320,944	\$263,901	-17.8%

Table 6. Virtual versus non virtual infrastructure study result summary

Once the environment was virtualized, shared storage became necessary. This added the cost of a SAN to the environment. This cost was somewhat offset by the 75.5 percent reduction in the storage disk requirement. The addition of the SAN also added 10 "U"s to the existing 12 "U"s of rack space required for the three physical servers that supported the virtual environment increasing the total to 22 "U"s. The SAN includes two controllers at 3 "U"s each and two disc enclosures of 2 "U"s each.

With significant differences between the two environments, the total equipment cost for each was about the same with a 3.7 percent price advantage going to the virtual environment. However, the advantages are more obvious when comparing the ongoing space, power, and licensing costs. As seen in the previous table, power costs are reduced by almost half and the infrastructure footprint is reduced by 58.5 percent. This rent reduction figure and/or rack cost was not considered in the final numbers as the benefit varies greatly depending on an organization's situation. However, when calculated, the savings would strengthen the advantages of virtualization.

What the table does not show is the time saved while managing the environment. For example, all 147 physical disks have to be managed and provisioned individually in the physical environment. In the virtual environment, the disks are managed centrally. When space begins to run out, another disk is simply added to the storage pool. Because so much time is saved with the virtual infrastructure in place, more can be done with significantly less.

Study Conclusions

The 17.8 percent cost savings alone achieved by moving to a virtual environment is significant. However, even if there were no upfront cost savings, the dynamic capabilities provided by the virtual environment enable significant advantages that justify the conversion. For example, the centralized storage component enables data progression, thin provisioning, and centralized storage management. Server virtualization enables Hyper-V and SCVMM to be managed by a centralized server. Server utilization improvement reduces the amount of servers that need to be managed. In addition, space, power, and cooling requirements are reduced. Best of all, virtualization enables faster upgrades or service rollouts that can be done in minutes rather than weeks.

Blueprint

The blueprint provided in this section is for a 500 user virtualized datacenter. The intention here is to provide a starting point for the reader to modify their environment for the specific needs of their organization. Again, the design was based on industry best practices, Microsoft guidance, and deployment calculators. The following figure provides the basic design.

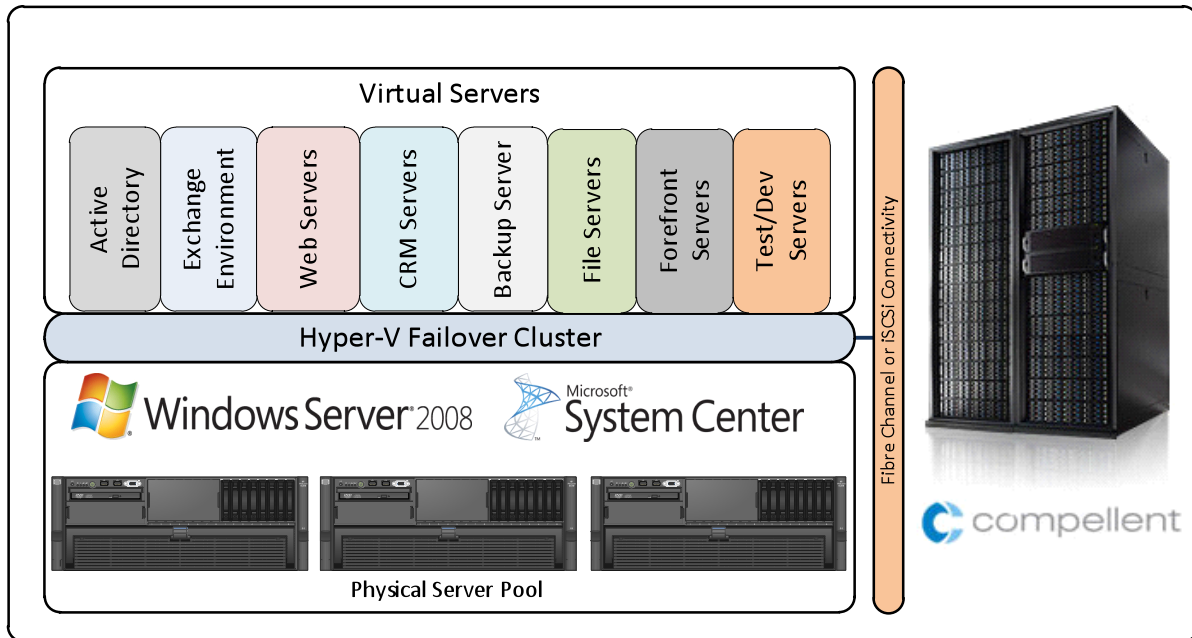


Figure 1: 500 user Compellent and Microsoft Hyper-V virtualized SMB environment

This entire infrastructure is built on top of three servers and a SAN. The servers need to be powerful or at least equivalent to the HP Proliant DL580 G5. Each server is configured with 16 cores and 96 GB of memory with four 146 GB 15K SAS disks. The Compellent Storage Center SAN is configured with dual controllers and two disk enclosures containing 24 disks, half of the disks are 450 GB SAS 15K and half are 1TB SAS 7.2K. The SAN is connected by Fibre Channel or iSCSI depending on the needs of the organization.

The physical servers are each running Windows Server 2008 R2 and are clustered using a Failover Cluster. This creates the physical server pool that can be divided up as needed to support each virtual server. The server pool is centrally managed using Microsoft System Center. After shared storage is created with the Compellent Enterprise Manager, SCVMM is used to create the individual virtual servers.

Please see the previous tables 4 and 5 for a complete breakdown of the individual servers to create and how to configure them. The high availability configuration requirements are listed in the following table. As each server is clustered, it should be noted that most pairs of servers signify a single cluster failover pair with the exception of Active Directory® and Exchange which both have their own replication. Also, in the case of Active Directory, the third server is necessary to support the development and test environment. It is also important to note that the backup server is redundant by definition and only requires a single server.

Server	High availability configuration
Exchange: Mailbox	Two individual servers
Exchange: CAS/Hub Transport	Two individual servers
Active Directory	Three individual servers including two servers to support the production environment and one server to support the development and test environment.
Web/SharePoint	Six servers configured as three single cluster failover pairs.
CRM	Two servers configured as a single cluster failover pair.
SQL Server	Two servers configured as single cluster failover pair.
Backup	One server to handle backup.
File servers	Two servers configured as single cluster failover pair.
Forefront	Two servers configured as single cluster failover pair.
Development/Test	Four servers configured as two single cluster failover pairs.

Table 7. High availability configuration

Virtualization Preparation

When an organization is ready to move to a virtualized dynamic datacenter environment, careful planning is important. This is the time that expert help is critical for the success of the venture. In addition, once a dynamic virtual datacenter is established, the way that the organization takes advantage of the dynamic capabilities must be considered.

Planning

Very few organizations start from scratch with their IT design and therefore the existing infrastructure must be considered when moving to a virtual datacenter. For this purpose, Microsoft and Compellent created some preliminary planning tools to help ease the process. The tools evaluate the existing infrastructure to determine if there are components that can be repurposed into the new virtual design and what additional hardware is required.

For example, the Microsoft Assessment and Planning (MAP) Toolkit is a powerful inventory, assessment, and reporting tool that can securely assess IT environments for various platform migrations and virtualization without the use of software agents. These are great tools to start planning and budgeting for the move to virtualization, however, organizations should contact their hardware vendor to help finalize the planning process. Please see the following links for more planning tool information:

- Compellent TCO tool:
<http://www.compellent.com/Solutions/Business-Need/Cost-Saving-Storage.aspx>
- Microsoft Virtualization Planning Tools:
<http://www.microsoft.com/virtualization/en/us/resources.aspx>

Integration

Many of the dynamic capabilities are simply part of the virtualized environment such as Live Migration, thin provisioning, or dynamic LUN expansion. But the dynamic datacenter can be automated or customized even further using Microsoft Windows PowerShell. For this purpose, Compellent created the Storage Center Command Set for Microsoft Windows PowerShell.

The Storage Center Command Set for PowerShell comprises more than 60 cmdlets for streamlining tasks such as:

- Microsoft Exchange e-mail environment storage creation.
- High availability cluster node storage mapping.
- Quick data recovery, speed testing, development, and deployment when booting new servers from the Compellent SAN.
- Automatic migration, cloning, and monitoring for hundreds of VMs across a virtualized data center.
- Rapid VM provisioning that can be fully integrated with SCVMM in a matter of seconds.

For more information about using the Storage Center Command Set for PowerShell, please see: <http://www.compellent.com/powershell>.

Conclusion

Microsoft and Compellent deliver end-to-end server and storage virtualization technologies that enable companies to amplify the cost savings and flexibility benefits provided by server virtualization. The combination of end-to-end server virtualization and management tools from Microsoft and advanced storage virtualization technologies from Compellent enable companies to create highly efficient, flexible, and easy-to-manage data centers that can adapt to changing business conditions.

Organizations can significantly lower the total cost of ownership by using green virtual storage to consolidate servers, maximize utilization, reduce the datacenter footprint, and cut power and cooling costs. The resulting virtual data center ensures continuous availability, and improved disaster recovery through instant local VM recovery and simple replication of virtual servers and storage.

The value of choosing Compellent to provide the virtualized storage component of this blueprint is that it just works. By starting from scratch, without the need to accommodate for software legacy code and proprietary hardware platform limitations, Compellent developed an innovative SAN that reduces storage costs, cuts storage administration time, and provides continuous data availability.

The combination of end-to-end server virtualization and management tools from Microsoft and advanced storage virtualization technologies from Compellent enables companies to create highly efficient, flexible, and easy-to-manage data centers that can adapt to changing business conditions.

Additional Information

To implement the blueprint provided in this paper, see the following links for additional information. To find out more about Compellent, please visit <http://www.compellent.com>.

When ready to take the next step, please contact Compellent sales at sales@compellent.com or contact by phone at (877) 715-3300.

For more information, please see:

Storage Center Overview:

<http://www.compellent.com/Products.aspx>

Compellent's Microsoft Alliance Web site:

<http://www.compellent.com/Microsoft>

Microsoft Virtualization Solutions:

<http://www.microsoft.com/virtualization/solutions>

Microsoft Virtualization Partners:

<http://www.microsoft.com/virtualization/en/us/partner-profile-compellent.aspx>