This document has been archived and will no longer be maintained or updated. For more information go to the Storage Solutions Technical Documents page on Dell TechCenter or contact support.

Compellent Storage Center

VMware vCloud Director

Best Practices Guide

Dell Compellent Technical Solutions Group
July 2013
# Table of Contents

1 Preface ................................................................................................................................. 1

1.1 Audience ........................................................................................................................... 1

1.2 Purpose ............................................................................................................................... 1

1.3 Customer Support ............................................................................................................. 1

2 Introduction .......................................................................................................................... 2

2.1 Introduction to vCloud Director ....................................................................................... 2

2.2 What’s New in vCloud Director 5.x .................................................................................. 2

2.3 vCloud Director Requirements ....................................................................................... 3

   2.3.1 Dell Compellent Storage Center .............................................................................. 3

   2.3.2 VMware vSphere ..................................................................................................... 3

   2.3.3 Red Hat Enterprise Linux ........................................................................................ 3

   2.3.4 Database Server ....................................................................................................... 3

3 vCloud Director Architecture ............................................................................................... 4

   3.1 vCD Layered Architecture ......................................................................................... 4

4 vCloud Director Installation ................................................................................................. 6

   4.1 Overview ....................................................................................................................... 6

   4.2 vCD Cell Server ............................................................................................................ 6

   4.3 Transfer Server Storage ............................................................................................... 6

   4.4 vCD Database .............................................................................................................. 7

   4.5 vSphere ......................................................................................................................... 7

5 vCloud Director Storage Management ................................................................................ 9

   5.1 Overview ....................................................................................................................... 9

   5.2 Dell Compellent vSphere Plug-in ............................................................................... 9

   5.3 Volumes and Datastores ............................................................................................ 9

   5.4 Storage Profiles .......................................................................................................... 9

   5.5 Availability .................................................................................................................. 10

   5.6 Performance ............................................................................................................... 10

   5.7 Capacity ...................................................................................................................... 11

   5.8 Zoning and Presentation ........................................................................................... 11

   5.9 Fast Provisioning and Linked Clones ....................................................................... 12
5.10 Raw Device Mappings (RDMs) .................................................................................. 14
6 Conclusion .................................................................................................................. 15
7 Additional Resources .................................................................................................. 16
  7.1 Dell Compellent Resources .................................................................................. 16
  7.2 VMware Resources .............................................................................................. 16
8 Appendix A – vCloud Director Configuration Maximums ....................................... 17
## Document Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Author</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/24/2012</td>
<td>A</td>
<td>Jason Boche</td>
<td>Initial draft</td>
</tr>
<tr>
<td>07/03/2012</td>
<td>B</td>
<td>Jason Boche</td>
<td>Spelling, versioning</td>
</tr>
<tr>
<td>07/12/2013</td>
<td>5.1.2</td>
<td>Jason Boche</td>
<td>Updated for vCD 5.x</td>
</tr>
</tbody>
</table>
1 Preface

1.1 Audience

The audience for this document is Architects and Systems Engineers who are responsible for the design, installation, and operations of VMware vCloud Director (vCD), VMware vSphere, and associated storage. Readers should have a strong working knowledge of vCD, vSphere 4.x/5.x, Dell Compellent Storage Center and Enterprise Manager.

1.2 Purpose

This document provides an overview of VMware vCloud Director and introduces best practice guidelines for configuring vCD when using the Dell Compellent Storage Center.

1.3 Customer Support

Dell Compellent provides live support 1-866-EZSTORE (866.397.8673), 24 hours a day, 7 days a week, 365 days a year. For additional support, email Dell Compellent at support@compellent.com. Dell Compellent responds to emails during normal business hours.
2 Introduction

2.1 Introduction to vCloud Director

This document will provide configuration examples, tips, recommended settings, and other storage guidelines for integrating VMware vCloud Director with the Dell Compellent Storage Center. This document has been written to answer frequently asked questions with regard to how vCloud Director integrates with Dell Compellent Storage Center, as well as basic configuration.

Compellent advises customers to read the vCloud Director documentation provided on the VMware web site before beginning their vCD implementation.

The information contained within this document is intended for general recommendations and may not be applicable to all configurations. There may be certain circumstances and environments where configurations could vary based upon business needs.

2.2 What’s New in vCloud Director 5.x

- Elastic vDCs – Virtual Datacenters can leverage resources across multiple clusters within a single vCenter Server.
- VXLAN and other networking improvements – Administrators can provision multi-tenant Layer 2 and Layer 3 networks quickly.
- Storage Profiles – Multiple tiers of storage can be presented and their capabilities easily identified from the Provider vDC to the Organization vDC using Dell Compellent VASA integration or manually defined capabilities. Storage Profiles can also be leveraged for the Storage vMotion and Storage Distributed Resource Scheduler (SDRS) support in vCD 5.x.
- API Extensibility Framework – vCloud Director workflow and automation can be leveraged via exposed APIs for better integration opportunities and end user customization.
- vApp Snapshots – vApps and their individual virtual machines allow create, revert, and consolidation of snapshots.
- Extended Platform Support – vCD cell servers are now supported on RHEL 6.3. SQL Server 2012 is supported for the vCD back end database. Microsoft Windows Server 2012 is supported for guest customization.
- vSphere 5 Support – vCD 5.1.2 is supported on vSphere versions up to 5.1 Update 1.
2.3  vCloud Director Requirements

2.3.1  Dell Compellent Storage Center

Storage Center 5.5.4 or newer is required with vSphere 5. Refer to the online VMware Compatibility Guide for the latest vSphere and Storage Center support matrix.

2.3.2  VMware vSphere

vSphere 4.0 Update 2 and newer is supported. vSphere includes the vCenter management server and ESX(i) hypervisor. vSphere 5.x is required for advanced features such as Fast Provisioning, Linked Clones, VM Hardware versions 8 and above, and VPN support. Refer to the latest vCloud Director Installation and Configuration Guide for changes and updates in supported versions.

2.3.3  Red Hat Enterprise Linux

When using the installable version of vCD, each cell server requires a 64-bit RHEL operating system. As of vCD 5.1.2, RHEL 5 Updates 4, 5, 6, and 8 as well as RHEL 6 Updates 1, 2, and 3 are supported.

2.3.4  Database Server

Oracle Database Server or Microsoft SQL Server is required for the vCD back end database. For version specifics, open a web browser to:
3 vCloud Director Architecture

3.1 vCD Layered Architecture

vCD is comprised of multiple components, each fulfilling a specific need. Each of the components is critical to the integrity of the vCD environment and should be considered in the design phase with resiliency and high availability in mind. If any of the components fail or are unavailable, vCD and its vApp workloads will not function properly.

Starting at the bottom of the stack is the Dell Compellent Storage Center which can provide multiple tiers of vSphere compatible block volumes to vSphere clusters. The ratio of Storage Centers to vSphere clusters may be one to one, one to many, many to one, or many to many. There are a few variables in the design to consider which will influence how storage is presented to vSphere. Both vSphere and vCD will abstract the Storage Center volumes presented up the stack. When architecting storage for a vCD environment, key metrics to determine success will be uptime/availability, performance, cost, and capacity/scalability, generally in that order. When architecting a cloud solution on Dell Compellent Storage Center, include redundant components as well as the appropriate spindle types and quantities, as well as RAID levels, to meet design requirements for availability, performance, and capacity. To make sure the system design will meet current requirements, near term, and future growth, a Dell Compellent Storage Architect should be consulted.

The next layer up is the vSphere virtual infrastructure, which is a consumer of storage performance and capacity, in addition to physical hosts, CPU, memory, network, management software, licensing, etc. vSphere is the first layer to abstract Dell Compellent storage from block volumes into VMFS formatted datastore objects. It is recommended to read and understand the Dell Compellent Best Practices with VMware vSphere 5.x document when deploying vCD on Dell Compellent Storage Center. Virtual Machines (VMs) are deployed as vApps by vCD onto vSphere compute, network, and storage resources ultimately provided by the cluster after a few iterations of abstraction. The vSphere layer also contains vCenter Servers, and depending on the vCD network configuration, each vCenter Server will be paired with a vShield Manager appliance which is used to manage and deploy vShield Edge appliances on-demand for vApp networking and isolation. Although the virtual infrastructure requires a vCenter Server, the management of most vCD resources and especially vApps should be performed using the vCD portal only.

The top layer contains the vCloud Director components. This includes one or more RHEL based front end servers which will each run a vCD Cell instance which users can log into in a load balanced fashion provided by a 3rd party load balancing solution provider. Solutions which do not require fault tolerance, resiliency, or load balancing can utilize a single cell server with either local block or remote NFS Transfer Server Storage. For solutions requiring fault tolerance, resiliency, and load balancing, multiple cell servers participate in a cluster.
sharing a single common NFS Transfer Server Storage volume and vCD database. The vCD database (SQL Server or Oracle) maintains critical information for the vCD environment and must always be available to the cell servers. Transfer Server Storage is a temporary holding tank used for uploading (importing) and downloading (exporting) vApps. Use of transfer server storage will vary based on operational characteristics of the environment. A multiple cell configuration will require an NFS volume to be shared among the cells as a common repository for transfers. A single cell configuration may use remote NFS storage or local block storage attached to the RHEL server. A key thing to remember is that once the first cell is installed and the transfer server storage location is defined, the transfer server storage location cannot be changed later. The architecture example in Figure 1 incorporates the Dell Compellent FS8600 (zNAS and NX3300 are also possible alternatives) to provide a transfer server storage volume on NFS. Each component is critical to the integrity of the vCD environment and should be considered in the design phase with resiliency and high availability in mind.

Figure 1.  vCloud Director Architecture Example
4 vCloud Director Installation

4.1 Overview

This document does not cover the installation in detail. VMware maintains a rich library of vCD documentation including the vCloud Director Installation and Configuration Guide in which ample instructions are provided to guide the installer through the deployment process. However, following these installation best practices will yield a more stable, and scalable vCD environment.

4.2 vCD Cell Server

A vCD installation will consist of one or more Red Hat Enterprise Linux cell servers each having multiple CPUs and a minimum of 1GB RAM (2GB recommended). The cell servers may be deployed on a virtual or physical hardware platform, or a mixture of both. The cell servers should be made highly available. This is especially the case if the design includes only one cell server for the environment. Cell servers will typically be installed on local attached disk which should be made highly available with an appropriate level of RAID. Performance characteristics of the cell server storage generally will not impact performance of the vCD environment because this storage is not used for disk intensive provisioning operations. There is one additional and important consideration for local cell server storage which is discussed in the next section titled Transfer Server Storage.

4.3 Transfer Server Storage

vCD leverages a Transfer Server for a few explicit operations including vApp uploading (importing), downloading (exporting), and in some cases, creating linked clones which span virtual datacenters (vDCs) that lack consistent datastore presentation. Transfer Server Storage is used as bulk storage capacity, a holding tank used temporarily by incoming and outgoing vApps. vApps, by virtue of being one or more encapsulated virtual machines, will require a large amount of transfer server storage capacity. VMware recommends as a rule of thumb at least several hundred gigabytes (GBs) of transfer server storage which will be consumed for a few hours by each transfer operation. Actual capacity requirements may vary. The transfer server storage path ($V CLOUD_HOME/data/transfer) is defined for the first time when the first cell server is deployed. Changing the path of transfer server storage is not supported by VMware once it is initially defined. This is why it is important to decide the path prior to deploying vCloud Director. In almost all cases, this should be an NFS volume accessible by all cell servers. The NFS volume must have write permission for the root account. An NFS volume is required for transfer server storage when the environment has multiple cell servers installed. The architecture example in Figure 1 incorporates the Dell Compellent FS8600 (zNAS and NX3300 are also possible alternatives) to provide a transfer server storage volume on NFS. Aside from ubiquitous file sharing across clustered hosts,
another benefit of NFS in this case is the ability to dynamically adjust volume capacity. For instance, if the transfer server storage was underestimated, the NFS volume can be easily grown to the proper capacity without impacting the storage hosts or vCloud Director.

If the environment will consist of a single cell server only, then the transfer server storage may be configured for local attached disk on the cell server itself (by default located at /opt/vmware/vcloud-director/data/transfer). However, as mentioned previously, this path may not be changed later without reinstalling vCloud Director. In terms of performance and capacity, capacity is going to be the most important design consideration (aside from high availability of course). Import and export operations are not inherently fast to begin with. As such, Tier 1 storage isn’t required for transfer server storage in most environments. Tier 2 or Tier 3 should suffice. Large vCloud environments characterized by constant transfer server operations may want to consider Tier 1 storage.

4.4 vCD Database

Each vCD cell server attaches to a single shared database hosted on Microsoft SQL Server or Oracle Database Server. Similar to the cell server, the database server may reside on either a virtual or physical platform. It is critical that the database be made highly available to all cell servers from an infrastructure perspective. vCD cells must be able to perform reads and writes to the database in order to function properly. The design should include the compute, network, and storage resiliency for the database server which may involve clustering. If the database files reside on Dell Compellent Storage Center, refer to the Dell Compellent Microsoft SQL Server Best Practices or Dell Compellent Oracle Best Practices document for recommendations pertaining to Microsoft SQL Server or Oracle respectively on Dell Compellent Storage Center. Consider using Dell Compellent Replays or other 3rd party protection methods to back up the vCD database and recover data as needed. Lastly, be sure to follow VMware’s requirements for database creation. These instructions can be found in the vCloud Director Installation and Configuration Guide.

4.5 vSphere

vCloud Director is deployed on top of an existing vSphere environment. Minimum requirements are vCenter 4.0 Update 2 and ESXi 4.0 Update 2. To leverage new features in vCD 1.5 such as Fast provisioning (Linked Clones), virtual machine hardware version 8 (along with its new capabilities), and advanced routing/VPN support, vSphere 5 is required for vCenter and the ESXi hypervisor. For greenfield deployments, deploy vSphere 5 with vCD to utilize the latest features and capabilities. It is recommended to read and understand the Dell Compellent Best Practices with VMware vSphere 5.x document when deploying vSphere 5 on Dell Compellent Storage Center. Follow storage best practices outlined in that supporting document unless explicitly stated otherwise in this guide.

The vSphere cluster should be licensed and configured for Distributed Resource Scheduler
(DRS) in fully automated mode. vMotion allows VMs and vApps to float between hosts in a cluster. Fully automated DRS leverages vMotion to migrate VMs and vApps as needed to balance resource utilization in the cluster and abide by affinity rules and maintenance mode operations.

If deploying vCD on top of a vSphere 5.0 environment where fast provisioning/linked clones will be used in conjunction with block datastores (i.e. Dell Compellent Storage Center), the number of ESXi hosts per cluster must be eight (8) or less. This is because vSphere 5.0 only allows up to eight ESXi hosts to access a virtual machine disk file (.vmdk) simultaneously. Linked clone vApps spanning nine or more hosts will fail to power on. vSphere 5.1 along with VMFS-5 relaxes this constraint by allowing up to 32 ESXi 5.1 hosts to share VMFS-5 datastores with linked clones.

The vSphere Storage DRS (SDRS) feature will migrate virtual machine files between datastores in a datastore cluster based on latency and capacity utilization. Prior to vSphere 5.1 and vCloud Director 5.1, mobility of vApps via SDRS was not supported. However, as of vSphere 5.1 and vCloud Director 5.1, SDRS is supported in a vCD environment. Before enabling SDRS in your vCloud environment, be sure to check the versions of vSphere and vCloud Director first. Dell Compellent generally does not recommend enabling SDRS migrations based on latency thresholds if more than one tier or RAID level backs the datastore.
5 vCloud Director Storage Management

5.1 Overview

Once vCloud Director has been deployed, Dell Compellent Storage Center volumes can be presented for use as cloud storage. Creation and management of the storage is not overly complex, but there are some best practices to follow and things to watch out for.

5.2 Dell Compellent vSphere Plug-in

The Dell Compellent vSphere Plug-in is a feature rich and robust integration tool which snaps into the vSphere Client. The plug-in is available from Dell Compellent’s Knowledge Center as a free download. Most of the commonly performed storage related tasks can be completed using the vSphere Client plug-in. Use the plug-in for operational items such as provisioning, detaching, and deleting datastores, configuring storage and replay profiles, expanding datastores, creating replays and replications, and deploying VMs from a template which can then be imported as a vApp into vCloud Director.

Figure 2. The Dell Compellent vSphere Client Plug-in

5.3 Volumes and Datastores

Dell Compellent Storage Center volumes may be created and presented to vSphere via a number of different methods, but the easiest and fastest way is to use the vSphere plug-in. Once the volume is provisioned and presented to vSphere and vCD, it is abstracted first as a datastore, and then a generally available cloud resource pool of storage. Whichever provisioning method is chosen, ensure that the process is consistent and the volume will meet availability, performance, and capacity requirements for the vApps deployed onto it. In some cases, these metrics will be formally defined by agreed-upon service level agreements (SLAs). Failure to meet SLAs may constitute a lack of vApp availability, poor performance, or breach of contract. Appropriate planning should be performed up front to guarantee storage resources.

5.4 Storage Profiles

As of vCloud Director 5.x, integration with vSphere Storage Profiles is supported. Underlying
storage capabilities (typically spindle, RAID, and replication attributes) can be passed to vCenter Server automatically via Dell Compellent’s VASA integration or via the manually defined method from a Storage or vSphere Administrator. After storage capabilities have been defined, Storage Profile functionality is manually enabled by a vSphere Administrator. After that, Storage Profiles are created manually, which individually tie to each unique string of storage capabilities. Once the Storage Profiles are created, they will be visible to the Provider vDC. In turn, the Storage Profiles can then be selectively exposed to Organization vDCs. This effectively allows a Provider vDC the ability to present multiple tiers of storage to Organization vDCs which are more easily identifiable and decipherable using Storage Profiles and VASA. Storage Profiles can also be leveraged in conjunction with vSphere Datastore Clusters and SDRS if the choice is made to enable SDRS automation in vSphere 5.1 and vCD 5.1. For more on SDRS, refer to section 4.5 above.

5.5 Availability

Storage availability and uptime is guaranteed by redundant physical hardware such as storage controllers, disk spindles, and power supplies. Path redundancy is provided by multiple fabrics, paths, HBAs, MPIO, and data written into RAID levels which tolerate one or more physical disk spindle failures.

5.6 Performance

Storage is presented to vSphere and then assigned in vCD to a Provider Virtual Datacenter (vDC). In this process, the storage is abstracted as a resource and is commonly identified by performance or SLA attributes (i.e. Gold, Silver, and Bronze). Storage performance is characterized by IOPS, throughput, and latency. Performance is guaranteed by backing a presented volume on an uncongested fabric with the appropriate tier of storage (tier 1, 2, 3, SSD, 15k, 10k, 7k) and choosing the appropriate RAID level via the Storage Profile for writes and reads. The fabric type and protocol may also play a performance role. iSCSI has come a long way in becoming a trusted and high performing protocol for demanding and enterprise scale environments. In many cases, iSCSI is adequate from a performance standpoint and may provide additional cost saving benefits. Fibre Channel is generally going to incur less latency and is not dependent on a shared Ethernet network infrastructure, but will typically have higher costs and distance complexities associated with it. Fibre Channel and iSCSI are both available in multiple fabric speeds which ties directly to performance.

Dell Compellent Storage Center is a fully virtualized array built on a Dynamic Block Architecture (DBA). One of the advantages of DBA is the ability to wide stripe volumes across multiple tiers of storage, in addition to writing and reading at multiple RAID levels on each tier of storage. Data Progression technology will migrate blocks or pages between RAID levels and tiers to provide the highest possible performance for active data in a vCD environment. The rules for where blocks of data are written to and read from are maintained in a storage profile which is applied on a per volume basis. Dell Compellent’s recommended
profile will utilize all available tiers of storage to provide the highest tier and RAID performance for active data, while aging and inactive data is eventually migrated to lower and less expensive tiers of storage. vApp data may also be "pinned" to a specific tier and RAID level using an alternate storage profile. When pinning data to a tier, it will never be migrated between tiers by Data Progression. All active and aged/stale data would remain together on one tier. When provisioning volumes for use with vCD, a storage profile choice must be made for each volume which will define where the data is written to and read from on the array. Although it is preferred to use the recommended profile from a cost savings and efficiency perspective, cloud providers may be required pin data to explicit tiers of storage based on SLAs or chargeback. In these cases, alternate or custom storage profiles can be used. When a storage profile has been applied to a volume at the time of creation, it can be subsequently changed at any time. Each volume assigned to a Provider vDC should have identical performance characteristics so that vApp performance is planned, predictable, and can be guaranteed.

5.7 Capacity

Available capacity is presented to vSphere and vCloud Director by the logical boundaries of the volume. The Storage Center Dynamic Capacity feature provides natively thin provisioned volumes which means thinly provisioned volumes are deployed by default with or without the available spindle capacity in the array. Free pages in the array’s page pool are only consumed at the time data is written to a volume. This is one method which Storage Center uses to provide up front capacity in a cost efficient manner. Data Progression creates spare capacity and space efficiency by migrating data to more space efficient RAID levels. When one volume is assigned to a Provider vDC, it will be thinly provisioned and pages will be consumed as data is written. When the volume is full or reaches a maximum capacity threshold, additional writes or vApp provisioning cannot occur. When multiple volumes are assigned to a Provider vDC, vCloud Director will provision vApps across the volumes in a way that consumes the volumes as evenly as possible based on available capacity. This is somewhat like a "fill and spill" pattern except spilling is ongoing to keep capacity utilization across volumes even rather than spilling once a volume is completely full.

5.8 Zoning and Presentation

Outside of vCloud Director, it is typically a best practice to confine the presentation of datastores within a cluster. This helps minimize complexity related to upgrading a vSphere environment and also helps keep the number of hosts per volume under the configuration maximum of 64. However, when provisioning storage in a vCD environment with intent to leverage linked clones, consideration should be made regarding the presentation of datastores across multiple clusters and vCenter Servers. When linked clones are deployed across datastores, the operation will take considerably less time if the host performing the operation has access to each of the datastores. If datastore access is limited within a cluster for example, then a linked clone operation which spans beyond the cluster boundary will
require uploading the vApp to the transfer server storage space, and then a subsequent download occurs from the transfer server to the host with access to the destination datastore. This process can be likened to the use of a "swing" volume to migrate VMs between clusters. If the same datastore is presented consistently across clusters or vCenter Servers, then a linked clone operation can bypass the use of the transfer server and the files can be copied directly by vCenter from the source datastore to the destination datastore. The next section goes into greater detail on linked clones.

If using linked clones across clusters or vCenter Servers, at a minimum, consider placing the most frequently used vApp templates and media files on a commonly shared datastore. Keep in mind vApp read I/O will stem from this datastore so the datastore should remain highly available and meet performance requirements.

5.9 Fast Provisioning and Linked Clones

VMware’s Linked Clone technology presents two immediate benefits to vCloud Director: fast provisioning and storage efficiency. While a full clone is the traditional method of creating a new virtual machine or vApp in which the entire virtual machine disk is copied during the creation of the new VM, a linked clone allows vApps to be created on “child” delta virtual disks from the “parent” virtual disks of a vApp. Instead of copying the full virtual disk file in a full clone, a small empty delta virtual disk is attached to the new vApp. Write I/O goes to the delta disk which eventually grows in size during the lifetime of the vApp. Read I/O starts at the delta disk and if the block of data is not contained there, the read operation moves up the “chain” to the parent virtual disk. The initial creation of the 16MB delta virtual disk for each VM in the vApp is how the cloning is able to be completed quickly, whereas in the past, the entire virtual disk was cloned, which could take several minutes or longer. The delta virtual disk’s small size provides the space efficiency of a linked clone configuration. VMware has further enhanced linked clones in vCD 1.5 such that they can span datastores, clusters, and even vCenter Servers. Although in some cases, full clones will be created with associated shadow VMs, the benefit of stretching linked clones across these boundaries is to provide the same vApp consistently throughout the cloud which may also stretch across the same boundaries. It is recommended to leverage space efficient linked clones where possible, keeping in mind that vSphere 5 is required for this functionality.

There are a few considerations when using linked clones. The first to note is that the parent-child chain length is limited to 30 for performance reasons. A chain links multiple generations of clones together. For example, A to B, B to C, and C to D. In this example, the chain length is four (4) and would look like this: A-B-C-D. Multiple chains can and will likely exist. For example, A to B, A to C, and A to D. In this example, multiple chain lengths of two (2) exist and would look like this: A-B, A-C, and A-D. It is the length of a single chain, not the number of chains that cannot exceed 30. Non-I/O intensive linked clone VMs will perform well but the latency generated for reads in a large chain eventually grows beyond tolerance thresholds. If a vApp is copied more than 29 times in a linked clone fashion, the
cloning operation will automatically invoke a full clone rather than allowing an additional linked clone which would bring the chain length to 31. If linked clone virtual machine performance degrades prior to the chain length of 30, a manual Consolidation process can be performed on the individual VM within the vApp. The chain length of the VM can be found by looking at the VM's property sheet and the Consolidation feature is found when right clicking on the VM. Consolidation is a disk I/O intensive operation that will convert a linked clone VM to a full clone. The operation is similar to vSphere snapshot consolidation. Depending on the chain length and the size of the delta disk, consolidation could take a considerable amount of time. Plan accordingly and do not perform several consolidation operations simultaneously.

For I/O intensive vApps, full clones are recommended rather than linked clones. VMware establishes I/O as intense at the 1,500 IOPS threshold. VMware's empirical data shows that virtual disk activity in excess of 1,500 IOPS will experience decreased throughput performance with linked clones. Another factor that plays a role in linked clone performance is the virtual disk type. For I/O intensive vApps, VMware recommends using thick eager zeroed disks instead of thin (sparse) disks which have a small block size of 512 Bytes. Sparse disks are beneficial for storage capacity efficiency but the small block size and associated metadata does not lend itself well to high performance requirements. Dell Compellent Storage Center supports the write same VAAI primitive and is also highly efficient in handling the writing of zeros to disk in terms of speed and capacity utilization. Storage Center tracks zero write requests but does not actually consume pages from the disk pool to actually write the zeros. For this reason, thick eager zeroed disks can still be created in a fast and space efficient manner.
5.10 Raw Device Mappings (RDMs)

Although the Dell Compellent vSphere Plug-in provides the capability to create a virtual or physical RDM, it should not be used provision RDMs of any kind in a vCloud Director environment. RDMs are not supported by VMware vCD. Furthermore, virtual machines and vApps, once managed by vCD, should not be altered outside of the vCD portal. vCD maintains the configuration and state most objects delegated to it in the vSphere cluster. Making modifications outside of vCD may produce unpredictable to negative results.
6 Conclusion

Dell Compellent Storage Center serves scalable, feature rich, easily managed virtualized storage for VMware vCloud Director environments of any size. Dynamic Block Architecture, Data Progression, and Dynamic Capacity combine to provide high performing and space efficient storage for elastic and unpredictable workloads found in private, public, and hybrid clouds.
7 Additional Resources

7.1 Dell Compellent Resources

- Knowledge Center - http://kc.compellent.com

7.2 VMware Resources

- Knowledge Base - http://kb.vmware.com
8 Appendix A – vCloud Director Configuration Maximums

The following configuration maximums apply to vCloud Director 5.1.2.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual machine count</td>
<td>30,000</td>
</tr>
<tr>
<td>Powered-On virtual machine count</td>
<td>10,000</td>
</tr>
<tr>
<td>Organizations</td>
<td>10,000</td>
</tr>
<tr>
<td>Virtual machines per vApp</td>
<td>128</td>
</tr>
<tr>
<td>vApps per organization</td>
<td>3,000</td>
</tr>
<tr>
<td>Number of networks</td>
<td>10,000</td>
</tr>
<tr>
<td>Hosts</td>
<td>2,000</td>
</tr>
<tr>
<td>vCenter Servers</td>
<td>25</td>
</tr>
<tr>
<td>Virtual Data Centers</td>
<td>10,000</td>
</tr>
<tr>
<td>Datastores</td>
<td>1,024</td>
</tr>
<tr>
<td>Catalogs</td>
<td>10,000</td>
</tr>
<tr>
<td>Media</td>
<td>1,000</td>
</tr>
<tr>
<td>Users</td>
<td>10,000</td>
</tr>
</tbody>
</table>