Private Cloud Storage Management using SMI-S, Windows Server, and System Center

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Agenda

Customer Pain Points
System Center Overview
SAN and NAS Management
Private Cloud Storage Provisioning
Fibre Channel Fabric Management
Applications with FC Storage
No automation. I have to wait for someone else to provision storage that I need for a deployment.

Targeted automation. My company invests in storage automation primarily to reduce human error.
No automation. I do not have the expertise to automate storage operations

50%
No automation. I am in API overload. Datacenter contains multiple arrays each with a different API surface.
System Center capabilities

**Infrastructure provisioning**
Enterprise-class multi-tenant infrastructure for hybrid environments

**Infrastructure monitoring**
Comprehensive monitoring of physical, virtual, and cloud infrastructure

**Automation and self-service**
Application-owner agility while IT retains control

**Application performance monitoring**
Deep insight into application health

**IT service management**
Flexible service delivery
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<th>Standards Based Management</th>
<th>Extensive Device Support SAN, NAS, FC Switch</th>
<th>VM, Host, and Cluster Storage Management</th>
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<td>End to End Discovery and Mapping</td>
<td>Allocation and Assignment</td>
<td>Storage Automation Built in Context</td>
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<td>Scalable Provisioning</td>
<td>Hybrid Cloud Scenarios</td>
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**Insight** | **Flexibility** | **Automation**
SAN Management

SAN (SMI-S)
Discovery array, pool, storage volume, initiators, targets, masking sets
Create/delete storage pool, storage volume, snapshot, clone

Hyper-V Server
Discovery of FC and IQN ports
Connect array to server (zoning, initiator logon)

Virtual Machine
Connect array to server (zoning, initiator logon)
Unmask/mask storage volume to VM
Add Storage Array Provider

```bash
$raa = Get-SCRunAsAccount -Name "NTAP"

Add-SCStorageProvider -Name "NETAPPSMI" -RunAsAccount $raa -NetworkDeviceName "http://NETAPPSMI.CONTOSO.LAB" -TCPPort 5988
```

NetworkAddress : http://netappsml.contoso.lab
TCPPort        : 5988
ProviderFlags  : StorageArray
RunAsAccount   : ntap
StorageArrays  : {myCloud}
* Make sure **key** properties are filled up appropriately. This diagram shows properties that "Windows Standards-Based Storage Management service" requires.
Capabilities and Services that may be traversed at Level 0

* Make sure key properties are filled up appropriately. This diagram shows properties that "Windows Standards-Based Storage Management service" requires.
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* Make sure **key** properties are filled up appropriately. This diagram shows properties that “Windows Standards-Based Storage Management service” requires.
Manage Storage Pool

$pool = Get-SCStoragePool -Name "vol2"
$classification = Get-SCStorageClassification -Name "HI-IOPS"
Set-SCStorageArray $pool.StorageArray -AddStoragePoolToManagement $pool
-StorageClassificationAssociation $classification

Enumerate
Enumerate SPCs

Select storage pools to place under management and assign a classification
Logical unit information will be imported from the selected storage pools. The assigned classification

Enumerate
StorageVolume

Enumerate
SPCs

SMDisplayName : vol2
Primordial : False
TotalManagedSpace : 2089072095232
Usage : Unrestricted
ProvisioningTypeDefault : Thin
SupportedProvisioningTypes : {Fixed, Thin}
StorageArray : myCloud
StorageLogicalUnits : {/vol/vol2/LU1-2ed3524-TR1701, /vol/vol2/DISK12,/vol/vol2/DISK03,
/vol/vol2/GUFS...}
* Make sure **key** properties are filled up appropriately. This diagram shows properties that “Windows Standards-Based Storage Management service” requires.
Make sure key properties are filled up appropriately. This diagram shows properties that “Windows Standards-Based Storage Management service” requires.
List Storage Volumes

(Get-SCStorageLogicalUnit | where {$_-StoragePool -eq $pool})[0]

SMName : b2c70854-874c-11e2-a2e0-123478563412
SMLunId : 600a09802d655533655d43423570646d
SMLunIdFormat : 9
SMLunIdFormatDescription : NAA
SMLunIdNamespace : 2
SMLunIdNamespaceDescription : VPD83Type3
TotalCapacity : 107374182400
StoragePool : vol2
Classification : HI-IOPS
StorageGroups : {vmmlab1823n3}
SAN and NAS Management
Storage Management API (SMAPI)

- Windows Server Server Manager
- ISV or Storage Vendor Applications
- System Center Virtual Machine Manager

Storage Management API (WMI)

- SMP Based Subsystem
- Storage Spaces Enclosure
- SMI-S Compliant Subsystem
- SMI-S Compliant NAS
- SMI-S Compliant FC Switch

CIM Pass Through
Architecture

- **VMM Server**
  - VMM Service
  - SMAPI
  - Storage Management Service
  - Discovery of Array, Pool and LUNS
  - LUN create, snapshot, clone
  - Mask and Unmask

- **Host**
  - ISCSI Initiator
  - HBA Provider
  - NPIV Provider
  - SMAPI
  - Enumerate
  - Rescan
  - Mount/UnMount
  - Volume to Disk mapping
  - Disk to LUN mapping

- **SAN, NAS**
  - Discovery of portals and targets log on & log off
  - Host

- **Device admin tool**
Scale-Out File Server Clusters
Storage Spaces Virtualization and Resiliency

- SMB
- Shared JBOD
- Scale-out File Server
- Spaces
- VMM
- File Server APIs
- SMAPI
- NAS (Self-contained NAS, NAS head)
- SMI-S Provider
- SAN (FC/iSCSI/SAS)
- SM API
- NAS
- FC/iSCSI/SAS
- AS SAN
Private Cloud Storage Provisioning
Storage Classification

Assign Classification to Storage
Create multiple classifications
Classify discovered storage pool, disk, and file share
Storage classification inheritance

Streamline VM Deployment
Express storage intent in templates
Placement is classification aware

Differentiate Capacity in Multi-Tenant Environment
Create clouds with specific classification
Self-service users restricted to allocated storage based on classification
Assign Classification to Storage

Storage Pool Classification

GOLD ➔ Assign ➔ Pool1 (GOLD)
Assign Classification to Storage

Storage Pool Discovery

<table>
<thead>
<tr>
<th>Storage Device</th>
<th>Pool ID</th>
<th>Classification</th>
<th>Total Capacity</th>
<th>Available Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>myCloud</td>
<td></td>
<td></td>
<td>4,747.26 GB</td>
<td>2,508.31 GB</td>
</tr>
<tr>
<td>vol1</td>
<td>CNTAPd669f7c-5c16-11e2...</td>
<td>Gold</td>
<td>2,801.66 GB</td>
<td>723.36 GB</td>
</tr>
</tbody>
</table>
Assign Classification to Storage

Inherited Classification

GOLD

Pool1 (GOLD)

LUN1

LUN2

LUN3 (GOLD)
Assign Classification to Storage

Storage Disk Classification
## Allocate Storage to Cloud

<table>
<thead>
<tr>
<th>Cloud Scope</th>
<th>Template Scope</th>
<th>Instance Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>No classification assigned to cloud</td>
<td>All classifications available on host group</td>
<td>Placement selected storage based on available capacity</td>
</tr>
<tr>
<td>Gold classification assigned to cloud</td>
<td>Limited to Gold classification</td>
<td>Placement selected Gold storage with available capacity</td>
</tr>
<tr>
<td>Gold and Silver classification assigned to cloud</td>
<td>Gold and Silver classification available</td>
<td>Placement selected storage based on selection in template and available capacity</td>
</tr>
</tbody>
</table>
Assign Classification to Storage

File Share Classification

Select file shares to place under management

Logical unit information will be imported from the selected storage pools. All physical disk information will be imported. Classification is required for storage pools. File share classification is optional. File shares without classification will get a default classification.

<table>
<thead>
<tr>
<th>Storage Device</th>
<th>Classification</th>
<th>Total Capacity</th>
<th>Available Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustered Storage Spaces on VMMR2RTMSTOR</td>
<td></td>
<td>20.476.25 GB</td>
<td>20.409.75 GB</td>
</tr>
<tr>
<td>TENADemoPool</td>
<td>SDS</td>
<td>20.476.25 GB</td>
<td>20.409.75 GB</td>
</tr>
<tr>
<td>vmmr2tmsdfs.dmchannel.lab</td>
<td></td>
<td>20.00 GB</td>
<td>19.79 GB</td>
</tr>
<tr>
<td>VMStore01</td>
<td></td>
<td>10.00 GB</td>
<td>9.90 GB</td>
</tr>
<tr>
<td>VMStore02</td>
<td></td>
<td>10.00 GB</td>
<td>9.90 GB</td>
</tr>
</tbody>
</table>
Assign Classification to Storage

Inherited Classification

Assign

SDS

Pool1 (SDS)

Share1

Share2

Share3 (SDS)
Fibre Channel Fabric Management
Topologies

- Physical or Virtual Machine
  - Masking
  - Zoning
- Fibre Channel
  - Block Storage SAN
- Ethernet (iSCSI)
  - Masking
  - Block Storage SAN
- Virtual Machine
  - Ethernet (SMB3)
  - File Storage
Storage Management API (SMAPI)

Storage Management API (WMI)

- SMP Based Subsystem
- Storage Spaces Enclosure
- SMI-S Compliant Subsystem
- SMI-S Compliant NAS
- SMI-S Compliant FC Switch

Windows Server
Server Manager

ISV or Storage Vendor Applications

System Center Virtual Machine Manager

CIM Pass Through
EnableManagement
Enumerate Zoneset
Enumerate Zone
Enumerate ZoneAlias
Enumerate Zone Members

$provider = Get-SCStorageProvider -Name "DCMRRSMISCISCO"
$fabric = Get-SCStorageFabric -Name "2002547FEE79EE81"
$classification = New-SCStorageFabricClassification -Name "PRODUCTION"
Set-SCStorageFabric -EnableManagement -StorageFabric $fabric -StorageFabricClassification $classification

ObjectId : CISCO_Vsan.CreationClassName="CISCO_Vsan",Name="2002547FEE79EE81"
ElementName : VSAN0002
Classification : PRODUCTION
StorageZoneSets : {Vsan2Active, Vsan2Active}
StorageZoneAliases : {t_alias1, t_alias3}
StorageZoneMemberships : {CISCO_ZoneMemberSettingData.InstanceID="2\2002547FEE79EE81\vm_0_zone\2\500507680220214\true" ...}
StorageZones : {dcmmr25r19n11, sfvcm1_zone, dcmr25r19n11, sfvcm1_zone...}
Storage Fabric Classification

Identify fabric using friendly name
Classification aware Placement

Select Fibre Channel fabrics to bring under management
Zoneset, zone, and zone member information will be imported based on the selected fabrics.

<table>
<thead>
<tr>
<th>Storage Device</th>
<th>Classification</th>
<th>Fabric WWNN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy</td>
<td></td>
<td>2003547FEE79EEB3</td>
</tr>
<tr>
<td>VSAN0001</td>
<td></td>
<td>2001547FEE79EEB3</td>
</tr>
<tr>
<td>VSAN0002</td>
<td>PRODUCTION</td>
<td>2002547FEE79EEB3</td>
</tr>
</tbody>
</table>

Hyper-V Clusters
- Virtual HBA
- Virtual SAN

Zone
- Fabric (PROD1)
- Fabric (PROD2)

FC Switches
Create Zone and Add Members (VMM)

#add list of zone members
$zoneset_newZone = Get-SCStorageZoneSet -Name "Active"

$newZone = New-SCStorageZone -Name "MyZone" -StorageZoneSet $zoneset_newZone - AddZoneMembership @("21240002AC000C63", "20230002AC000C63", "10000000C9C17FCA", "10000000C9C17FCB")
Activate Zoneset (VMM)

```powershell
#Activate zoneset
If($zoneset_newZone.Active -eq $false)
{
    Set-SCStorageZoneSet -StorageZoneSet $zoneset_newZone -Enable
}
```
Applications with FC Storage
Problem Statement

Multi-tier application that requires a SQL database deployed on a failover cluster with shared FC storage from a SAN
Application Environment Details

**Fibre Channel Switches**
Dual redundant fabrics between hosts and storage

**Hyper-V Host**
Hosts with at least 2 FC ports
Connect each FC port to a different fabric
Create a virtual SAN per fabric

**SQL Tier Service deployment**
Partnerships
Storage Manageability Certification

Windows Server Server Manager

ISV or Storage Vendor Applications

System Center Virtual Machine Manager

Storage Management API (WMI)

CIM Pass Through

SMP Based Subsystem

Storage Spaces Enclosure

SMI-S Compliant Subsystem

SMI-S Compliant NAS

SMI-S Compliant FC Switch

VMM Based Scenario Tests

Native SMAPI Functionality Tests

SNIA SMI CTP
Thank you!

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MASKING and MAPPING IN-DEPTH
MASKING IN-DEPTH

- SCSI Protocol Controller
  - a.k.a. Storage Groups
  - a.k.a. Masking Sets
  - a.k.a. Host Groups
  - a.k.a. View
- Ports Per View
  - Array target ports
- One Hardware ID Per View
  - Server initiator ports
SCSI Protocol Controller

- SCSI protocol controller (SPC) is a grouping mechanism on the array using for exposing a storage volume (LUN) to a Windows server
- SPC contains target ports (array), storage volumes (LUN), initiator ports (Windows host)
Ports per SPC

- Controls how many array target ports an SPC can have
  - All Ports Share Same View – All targets ports in SPC
  - Multiple Ports Per View – one, some or all target ports in SPC
  - One Port Per view – one target port in SPC
All Ports Share Same SPC

- SPC includes all of the target ports on the array
Multiple Ports per SPC

- SPC includes all, some, or one of the target ports on the array
One Port per SPC

- SPC includes only one target port on the array
# Ports per SPC

<table>
<thead>
<tr>
<th>Setting</th>
<th>Implementation Notes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Ports Share Same View</td>
<td><strong>Simplicity</strong></td>
<td>NetApp FAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HP EVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMC Clariion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dell Compellent</td>
</tr>
<tr>
<td>Multiple Ports Per View</td>
<td><strong>Flexibility</strong> (can mimic both One Port per View and All Ports Share Same View)</td>
<td>EMC VMAX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HP 3PAR</td>
</tr>
<tr>
<td>One Port Per View</td>
<td><strong>Traditional</strong></td>
<td>Hitachi VSP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HP P2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hitachi AMS</td>
</tr>
</tbody>
</table>
One Hardware ID per SPC

- One Hardware ID per SPC == True
- One Hardware ID per SPC == False

Diagram showing the relationship between VM hosts, storage arrays, and protocol controllers (SPC) for both cases.
# One Hardware ID per SPC

<table>
<thead>
<tr>
<th>Setting</th>
<th>Implementation Notes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRUE</td>
<td>Traditional</td>
<td>Hitachi AMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HP P2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dell Compellent</td>
</tr>
<tr>
<td>FALSE</td>
<td>Flexibility (allows for one SPC per cluster)</td>
<td>EMC VMAX, Clariion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IBM XIV, SVC, V7000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HP EVA, 3Par</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NetApp FAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hitachi VSP</td>
</tr>
</tbody>
</table>
SPC Creation for Clusters

Create SPCs per Cluster

- Create SPCs per Cluster == True
  - Creates storage groups that contain all initiator ports for all nodes in the cluster

- Create SPCs per Cluster == False
  - Creates a storage group that contain all initiator ports for each node in the cluster
# SPC Creation for Clusters

<table>
<thead>
<tr>
<th>Setting</th>
<th>Implementation Notes</th>
<th>Examples</th>
</tr>
</thead>
</table>
| TRUE    | On some arrays, unmasking operations get serialized so the time required to unmask a LUN to multiple nodes in the cluster increases (minutes)  
No flexibility to have a separate LUN for boot from SAN | EMC VMAX  
Hitachi VSP | |
| FALSE   | Offers the most flexibility if you want to expose LUNs to a subset of nodes in the cluster (e.g. to enable boot from SAN) | NetApp FAS  
HP 3AR  
Dell Compellent | |
<table>
<thead>
<tr>
<th>One Hardware ID Per SPC == FALSE</th>
<th>All Ports Share Same SPC</th>
<th>Multiple Ports Per SPC</th>
<th>One Port Per SPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create SPCs per Cluster == True or False</td>
<td>Create SPCs per Cluster == True or False</td>
<td>Create SPCs per Cluster == True or False</td>
<td>Create SPCs per Cluster == True or False</td>
</tr>
<tr>
<td>Create SPCs per Cluster – Not Applicable</td>
<td>Create SPCs per Cluster - Not Applicable</td>
<td>Create SPCs per Cluster - Not Applicable</td>
<td>Create SPCs per Cluster - Not Applicable</td>
</tr>
</tbody>
</table>
- **All/Multi** Ports per SPC
- One Hardware ID per SPC == **False**
- Create SPCs per Cluster == **True**

- **All/Multi** Ports per SPC
- One Hardware ID per SPC == **False**
- Create SPCs per Cluster == **False**
- **One** Port per SPC
- **One Hardware ID per SPC == False**
- Create SPCs per Cluster == **True**

- **One** Port per SPC
- **One Hardware ID per SPC == False**
- Create SPCs per Cluster == **False**
- **All/Multi** Ports per SPC
- One Hardware ID per SPC == **True**
- Create SPCs per Cluster – **N/A**
- **One** Ports per SPC
- One Hardware ID per SPC == **True**
- Create SPCs per Cluster – **N/A**
**ISCSI Target Models**

Masking/Mapping depends on Target model

Types of target models

- **Static**
  
  Targets are static as fiber channel targets usually one per Ethernet port or pre setup. #of static iscsi targets won’t change for life time of array unless there configuration change.

- **Dynamic**
  
  Targets are dynamic. Two type of dynamic target systems.
  
  - **Automatic**
    
    Targets are created automatically one per volume upon volume creation.
  
  - **Manual**
    
    Targets can be created by user based as they need.
Using iSCSI Configuration Service Capabilities

Static target model
Absence of iscsi configuration capabilities instance or following values would be discovered as static target model.

```
iscsiConfigurationCapabilitiesInstance->ISCSIProtocolEndpointCreationSupported = false
iscsiConfigurationCapabilitiesInstance->ISCSINodeCreationSupported = false
```

Automatic target model

```
iscsiConfigurationCapabilitiesInstance->ISCSIProtocolEndpointCreationSupported = true
iscsiConfigurationCapabilitiesInstance->ISCSINodeCreationSupported = false
```

Manual target model

```
iscsiConfigurationCapabilitiesInstance->ISCSIProtocolEndpointCreationSupported = false
iscsiConfigurationCapabilitiesInstance->ISCSINodeCreationSupported =
```
Static target model
Mask/unmask same as Fiber channel target ports described earlier i.e. depends on PortsPerView, OneHardwareIDPerView and MaxMapCount properties. VMM expects iscsi login as precheck for provisioning which can be automated as part of array onboarding per host.

Automatic target model
ISCSI targets are 1:1 to volume hence one SPC per volume i.e. volume is key for SPC. Masking is nothing but adding and removing initiators from SPC.
SPC is created by VMM upon first time volume is unmasked, provider needs to establish its association with specific target automatically. VMM will issue ISCSI login/logoff per target upon provisioning.

Manual target model
Provides flexibility to create targets as needed. SMAPI doesn’t expose target creation api’s. Solution is for provider to create target automatically per SPC creation from VMM. Here initiators become key for SPC. Once SPC created masking is nothing but adding removing volumes from SPC. VMM issues iscsi login/logoff upon provisioning.
Notes for iSCSI Masking

Masking capabilities not per protocol

This could be tricky for arrays which implement different target models for iSCSI vs fiber channel. For example FC is static target system where as ISCSI is dynamic target system.

Some workaround available. To mitigate VMM relies on ISCSI configuration capabilities for ISCSI before looking into Masking capabilities. However some combinations may not work.

Automatic target model not scalable.

Since there is 1:1 SPC per volume system could end up with too many SPCs potentially max number of volumes. This causes scalability and performance issues not only from provider but also from host initiator.
Group Masking

Basically group masking allows SPC to be associated with initiator group, volume group and port group. These groups can be nested.

Support for group masking with following limitations

Only single level groups are supported i.e. nested groups not supported.

New initiator group and volume group are automatically created per spc creation and destroyed as spc goes away.

Target port group are not created automatically. This needs to be created out of band. This is done to facilitate reuse of target port groups.

Recommendation

Use masking/mapping profile as all scenarios can be addressed with this.