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IBM Spectrum Control Base
Enabling VMware Virtual Volumes with IBM XIV Storage System

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Introduction

With the announcement of vSphere 6.0, VMware also officially released support for the vSphere Virtual Volumes (VVOL) architecture. VVOL allows more efficient operations and control of external storage resources, such as the IBM® XIV® storage system.

This IBM Redpaper publication provides a short overview of the VVOL architecture implementation in XIV. The integration of VVOL with XIV is based on the VMware APIs for Storage Awareness (VASA). The IBM support for VASA is delivered as part of IBM Spectrum Control.

This paper discusses the prerequisites and shows a step-by-step illustration on how to practically set up XIV to support and use vSphere Virtual Volumes.

Introduction to vSphere Virtual Volumes

Before the availability of vSphere Virtual Volumes, a virtual machine (VM) in a VMware environment would be presented a disk in the form of a file called a VMware disk (VMDK). This file represented a physical disk to the VM and could then be accessed by the operating system installed on the VM in the same way a physical volume on a regular server was. The VMDK file was then placed onto a file system called VMFS (VMware file system) hosted by a standard volume (LUN), for example implemented on external storage system such as XIV.

Although this design has the advantage of simplicity, it also imposes constraints and limitations on the management of the VM data. Indeed, the Storage Administrator and the VMware Administrator need to agree about the size and placement of volumes in the storage array before the deployment of VMs. This approach presents scalability and granularity issues, and cannot respond to the needs of businesses in a dynamic fashion. It also inhibits using advanced storage system functions such as instant snapshots and replication, and complicates backup solutions.

With the availability of the vSphere Virtual Volume technology, each VM disk can now be mapped to an external storage volume (for example, an XIV volume).

Tip: With VVOL, the XIV Storage System becomes aware of individual VMDK files, and data operations such as snapshot and replication can be performed directly by XIV, at the VMDK level rather than the entire VMFS datastore.

Figure 1 shows how VVOL changes the landscape of storage in a virtualized environment.

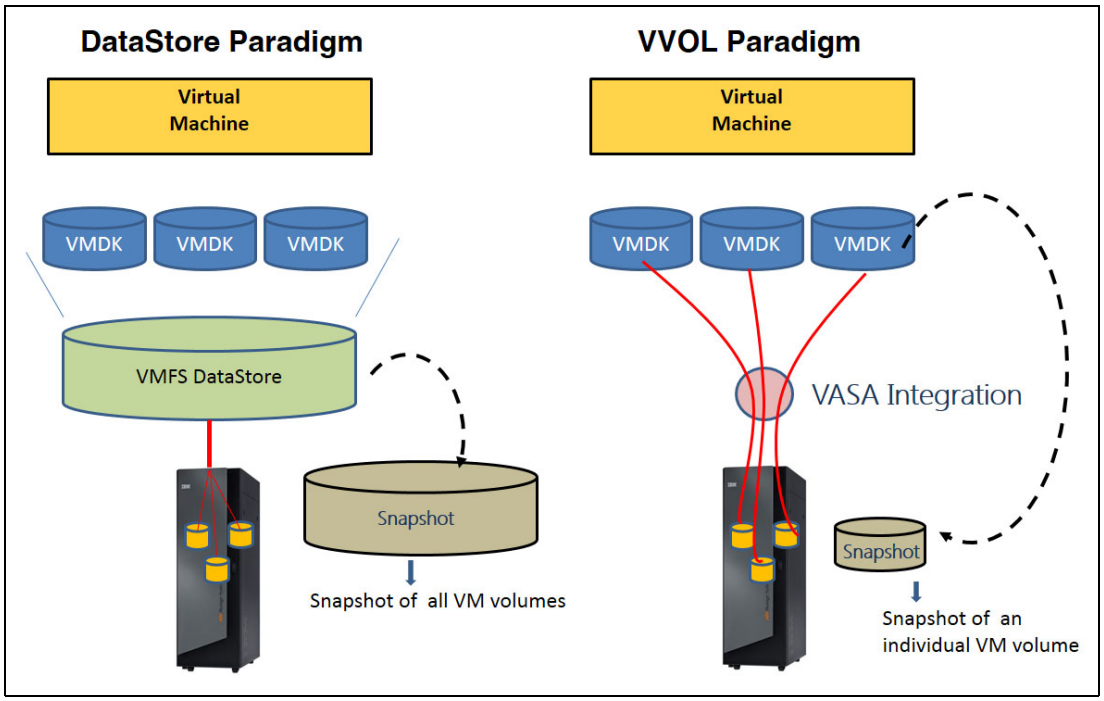

Figure 1 VMFS datastore and VVOL paradigms

VVOL implementation in XIV

The VVOL architecture maintains the concept of VMDK files and remains compatible with data storage implementations already in place. However, under the VVOL technology that XIV supports, each VMware VM disk can correspond to an XIV volume and can use the storage functions that apply to an XIV volume, such as encryption, snapshot, and replication.

XIV uses VASA to present virtual volumes to the ESXi host and inform the VMware vCenter of the availability of VVOL aware storage. Refer to Figure 2 on page 3.

Storage containers are configured on VASA by the storage administrator and are used to manage VVOLs and storage resources. Storage containers represent a grouping of virtual volumes attached to a VM. In the XIV implementation, VASA associates a storage container with a single XIV pool and uses it to present the pool resources to vSphere.The storage containers are characterized by storage services and combine storage capacity with a set of attributes, such as encryption or provisioning type. The storage container is used as virtual datastore to match the requirements of a specific VM and constitutes the basis of a Storage Policy Based Management.

VASA uses the concept of an Administrative Logical Unit (ALU), which is the SCSI object, essentially appearing as a LUN that redirects the SCSI stream to its underlying virtual volumes. As such, VVOLs are not mapped directly to a host like regular volumes. Rather, they are bound to a host through the ALU. The ALU is also known as the Protocol Endpoint LUN. The Protocol Endpoint (PE) represents the access point from VM hosts to the storage system, and allows the storage system to carry on storage-related tasks on behalf of the ESXi hypervisor.

To separate the management of regular storage pools in XIV from those managed through VASA, they are grouped into separate XIV domains. The VASA provider must be assigned to and control a single domain. Because that domain will not be directly managed by the storage administrator, it is marked as an externally managed domain. A new user role, Storage IntegrationAdmin, is introduced in XIV, and is required to perform specific operations on a managed domain.

The VASA implementation that is provided by IBM is now packaged with IBM Spectrum Control Base, formerly known as the IBM Storage Integration Server (Figure 2).

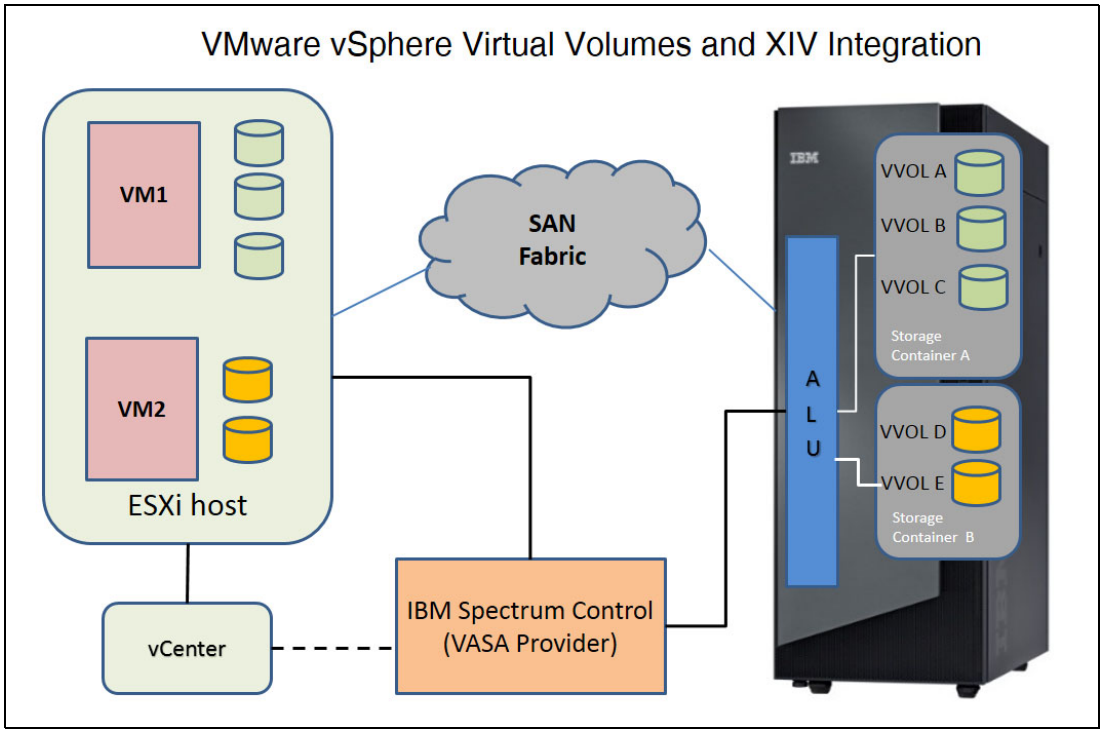

Figure 2 VVOL and XIV integration

VVOL concepts mapping in IBM Spectrum Control Base Edition

Figure 3 shows a detailed mapping of VMware Virtual Volumes concepts in IBM Spectrum Control Base Edition and IBM XIV:

- A VMware *virtual volume* maps to an IBM XIV *volume* (or *LUN*)
- A VMware *Storage Container* maps to an IBM Spectrum Control *Storage Resource*
- VMware *VVOL Datastore Capabilities* map to an IBM Spectrum Control *VVOL service*

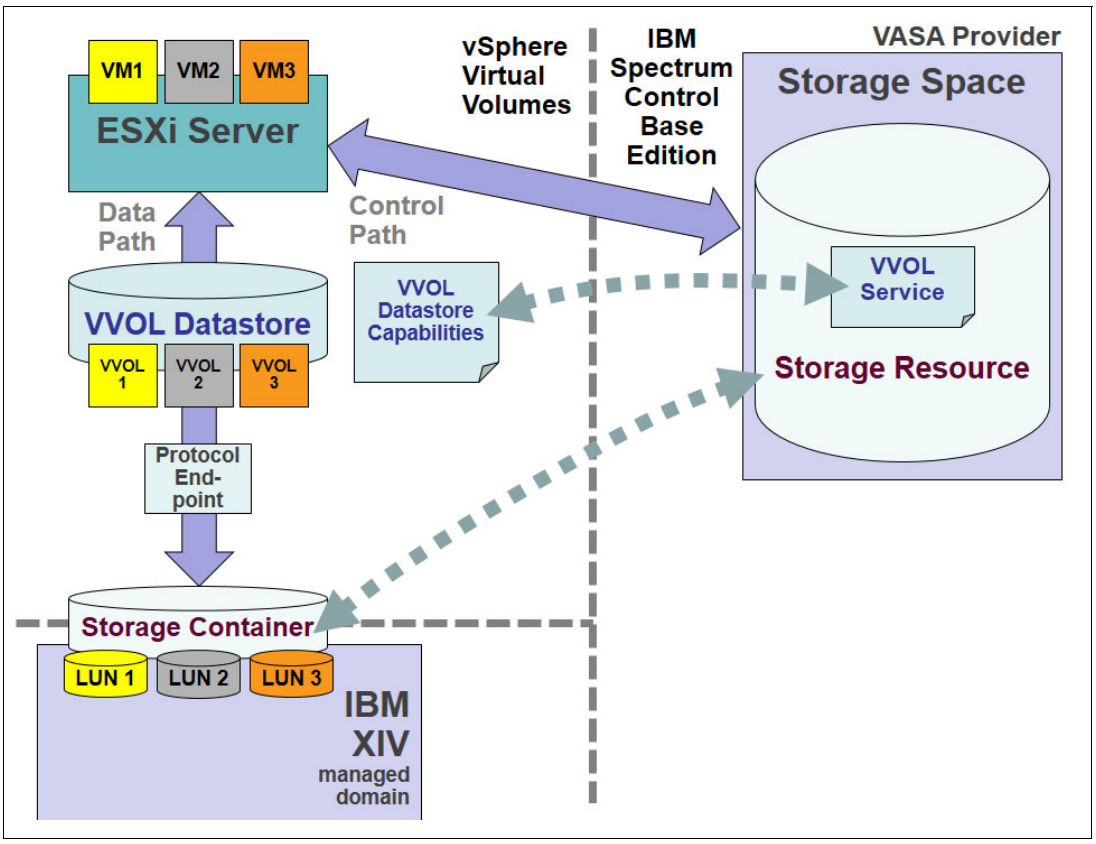

Figure 3 VVOL Concepts mapping with IBM Spectrum Control Base Edition

Defining Virtual Volumes in XIV

This section provides a quick overview of the requirements and practical tasks to perform for defining and using vSphere Virtual Volumes with XIV.

Prerequisites and configuration

The following software and specific versions are required:

- VMware vCenter 6.0 server installed
- ESXi 6.0.0 server installed

- IBM Spectrum Control Base 2.0.0 installed. The Linux installation package can be downloaded from IBM Fix Central at:

  http://www.ibm.com/support/fixcentral/

  Specify **IBM Spectrum Control** as the product.
- ESXi managed by vCenter

The following configurations must be completed to connect the VMware infrastructure with an IBM XIV through the VASA interface. To enable VVOL for this IBM XIV, complete these steps:

- Configure the XIV Storage System to create a managed domain for all VVOL resources
- Configure IBM Spectrum Control to connect to the XIV storage
- Configure VASA on both vCenter and IBM Spectrum Control

IBM XIV configuration

The following configuration steps need to be completed on the XIV Storage System:

1. Create a domain that includes all XIV GUI elements involved in the VVOL infrastructure. These tasks can be accomplished either through the XIV GUI, or by using the XCLI. This example shows these configuration steps with the XIV GUI:
   a. Create a managed domain to hosts VVOL-related XIV elements.
   b. Create a user in this domain with the Storage Integration Administrator role.
   c. Define the VMware ESXi hosts in this domain.
2. Make the created domain an externally managed domain. These required steps must be completed in the IBM XCLI:
   a. Enable metadata service for the IBM XIV.
   b. Configure created domain to be a managed entity.
   c. Create a XIV administrative logical unit for each VMware ESXi host

Create an IBM XIV domain for all VVOL components

The following steps need to be completed to create an IBM XIV domain:

1. From the XIVGUI, log on as the storage administrator.
2. The storage components used as VVOL must be in an XIV managed domain, so an XIV domain must be created:
   a. From the XIV GUI main window, select **Actions**, then **Create Domain** as shown in Figure 4.

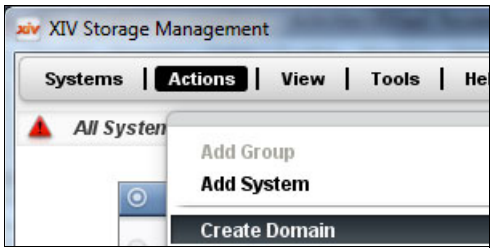

Figure 4 Calling create domain wizard

b. The **Create Domain** wizard window pops up. Specify domain hard size and soft size, making sure that the soft size is four times larger than hard size (if you are going to use thin provisioning), and enter a domain name, as shown in Figure 5.

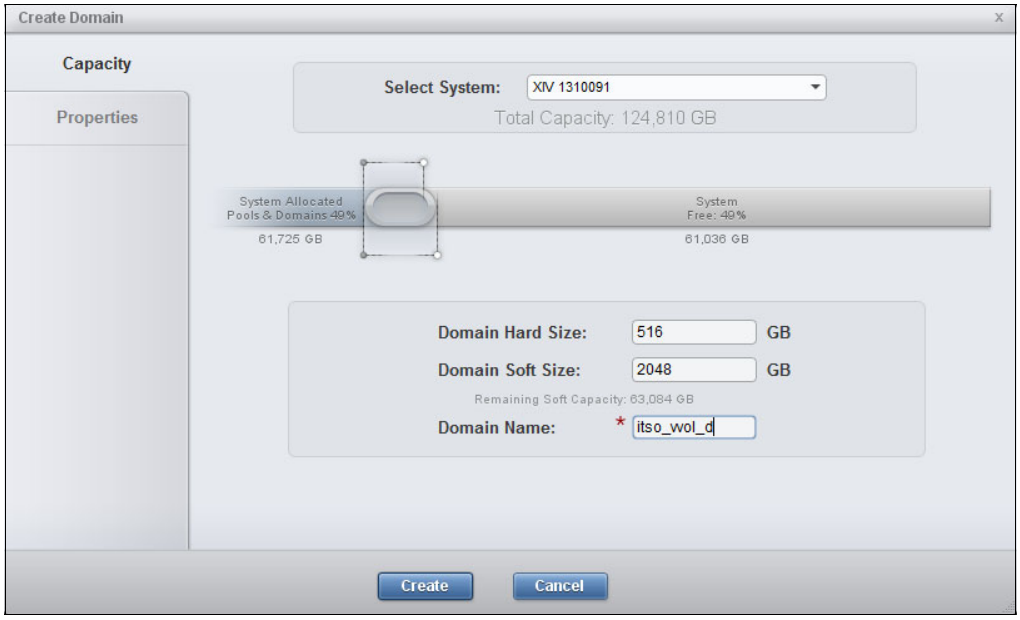

Figure 5 Filling capacity tab when creating domain

c. In the **Properties** tab, specify at least Max. Pools as 3, as shown in Figure 6. This minimum is required because whenever a VVOL is created by IBM Spectrum Control, three pools are created:

   i. Meta Pool: Holds VMware virtual machine-related management metadata
   ii. Thick Pool: For thick provisioning
   iii. Thin Pool: For thin provisioning

   Specify the other parameters according to your needs, then click **Create**.

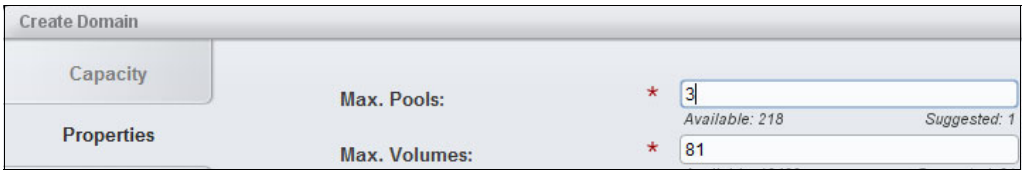

Figure 6 Specifying at least three pools in the domain

3. An XIVGUI user with Storage Integration Administrator role must be created and associated with this domain. Complete these steps:

   a. Click the **Padlock** icon, then select **Users**, as shown in Figure 7.

Figure 7 Opening the user management page

b. In the user window that opens, click **Add User** as shown in Figure 8.

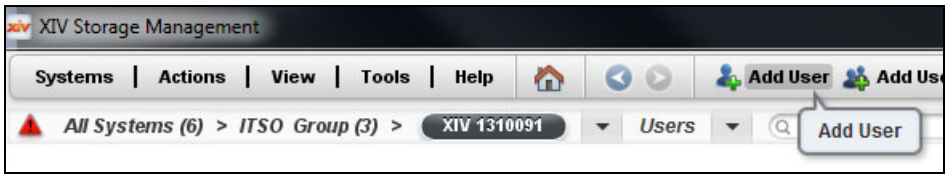

Figure 8 Calling Add User wizard

c. The **Add User** wizard window is displayed. Enter the name of the domain previously created, and the category **Storage Integration Administrator**, as shown in Figure 9, and then click **Add**.

Figure 9 Filling user properties

4. The VMware ESXi hosts featuring VVOL need to be defined in the newly created domain. Complete the following steps for each of these hosts:

   a. Click the **Hosts** icon, then select **Host and Clusters**, as shown in Figure 10.

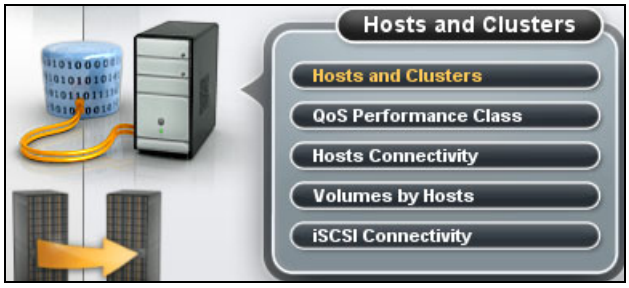

Figure 10 Launch Host and Clusters page

b. The **Hosts and Clusters** page opens. Click **Add Host** as shown in Figure 11.

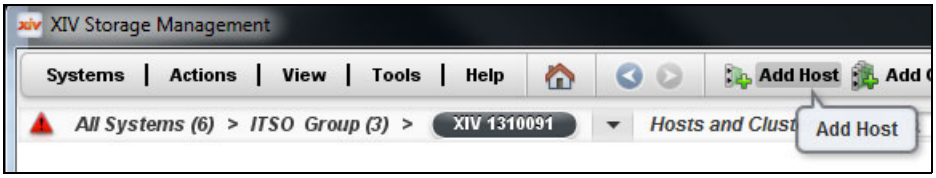

Figure 11 Starting the Add Host wizard

c. The **Add Host** wizard window opens. Specify the previously created domain name, as shown in Figure 12, and click **Add**.

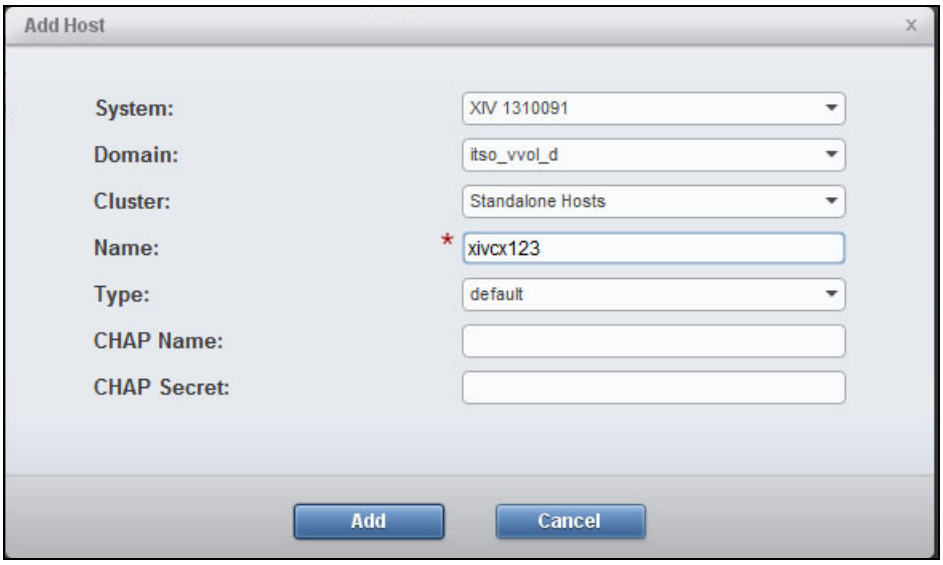

Figure 12 Filling Add Host wizard

5. The newly created hosts now need to be mapped to the corresponding Fibre Channel ports. For this purpose, complete the following steps for each ESXi host:

   a. From the Hosts and Clusters page, right-click the newly created host and select **Add Port**, as shown in Figure 13.

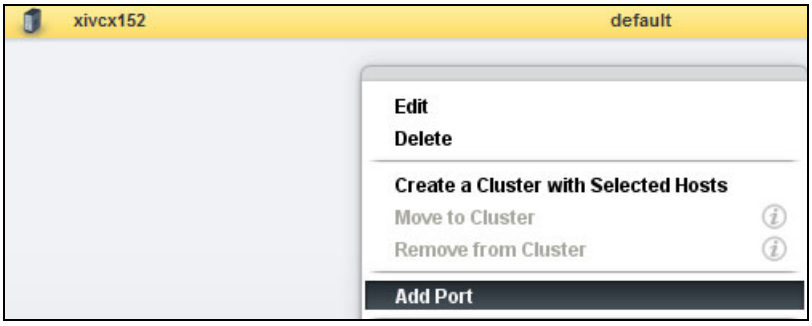

Figure 13 Starting the Add Port wizard

b. Search for the ESXi host port name in the drop-down list and click **Add**, as shown in Figure 14. Repeat this step for each ESXi port.

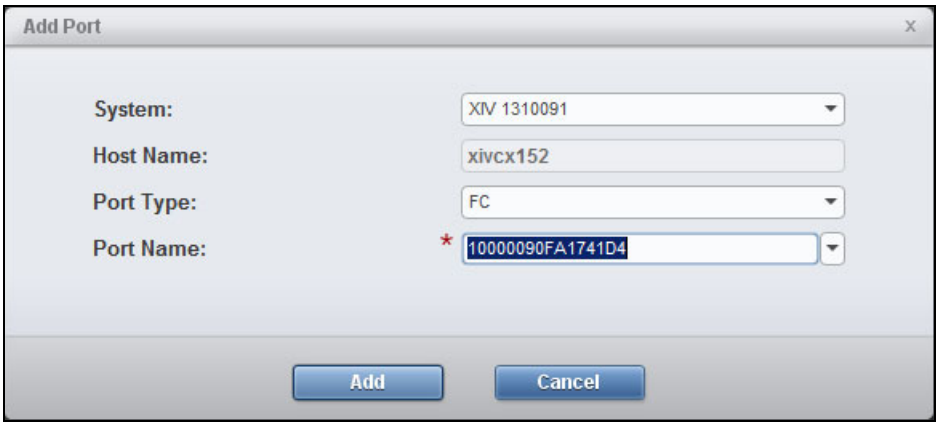

Figure 14 Adding a port to a host

Tip: To retrieve the ESXi port names, issue the following command from an SSH session to your host:

```
[root@xivcx123:~] esxcli storage san fc list | grep "Port Name"
   Port Name: 10:00:00:90:fa:17:41:d4
   Port Name: 10:00:00:90:fa:17:41:d5
```

You can also retrieve the ESXi FC ports from the vSphere management.

c. Your added ports then appear in the **Host and Clusters** window as shown in Figure 15.

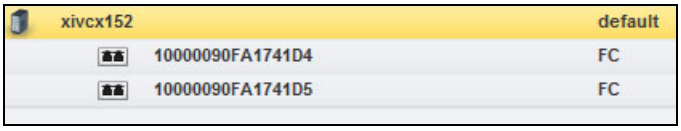

Figure 15 Fibre Channel port defined on a host

Make new domain a managed domain

The following steps need to be completed to make a new domain:

1. Log on to your XCLI as user **admin**. Enable metadata service using the command shown in Example 1.

Example 1 Enabling metadata service

```
XIV 1310091>>metadata_service_enable
Command executed successfully.
```

2. Log on to the XCLI with the user (Storage Integration role) you created at step c on page 7 and complete the following steps:

   a. Configure the domain that was created at step b on page 6 to be managed, using the command shown in Example 2.

   Example 2 Configure domain to be managed

```
XIV 1310091>>domain_manage domain=itso_vvol_d managed=yes
Command executed successfully.
```

   b. Create a administrative logical unit for each VMware ESXi host using the command shown in Example 3 with the following parameters:

   alu A name for this administrative logical unit
   host The ESXi host as defined in IBMXIV by step c on page 8
   lun Any unique number between 512 and 755

   Example 3 Creating administrative logical unit

```
XIV 1310091>>alu_create alu=itso_vvol_a host=xivcx123 lun=600
Command executed successfully.
```

IBM Spectrum Control configuration

After the XIV Storage System has been configured, it needs to be known to IBM Spectrum Control. The following are the high-level steps needed to do this:

- First-time IBM Spectrum Control configuration
  - Define the IBM Spectrum Control fully qualified domain name and high availability group
  - Generate a server certificate
- Set up VASA credentials
- Set up XIV credentials
- Add the XIV Storage System
- Create a storage space for this XIV in Spectrum Control
- Add a VVOL-enabled service for this storage space
- Define a storage resource with this VVOL-enabled service

A detailed description of these steps follows:

1. Log in to IBM Spectrum Control Web Interface:

   http://IBM_Spectrum_Control_IP_address:8443

2. Enter the default login credentials, which are user **admin** and password **adminadmin**, as shown in Figure 16.

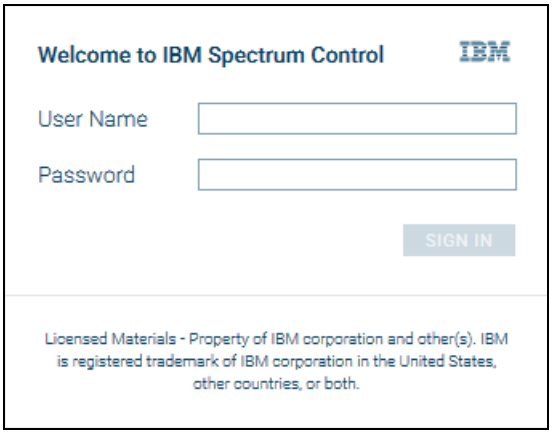

Figure 16 Log in to the IBM Spectrum Control user interface

3. If needed, complete these first-time configuration steps:
   a. To configure IBM Spectrum Control fully qualified domain name, click the configuration icon, then select **SETTINGS** as shown in Figure 17.

Figure 17 Opening the general settings form

   b. Complete the general settings form as shown in Figure 18 on page 12, with the following parameters:

FDQN	Fully domain qualified name of IBM Spectrum Control server
HA GROUP	High Availability group containing this IBM Spectrum Control server

   The first defined IBM Spectrum Control server within a HA group is the active server, whereas the second one is the standby one.

   For more information about IBM Spectrum Control high availability feature, see the I*BM Spectrum Control Base User Guide*, which is provided when you download IBM Spectrum Control Base from IBM Fix Central (see “Prerequisites and configuration” on page 4).

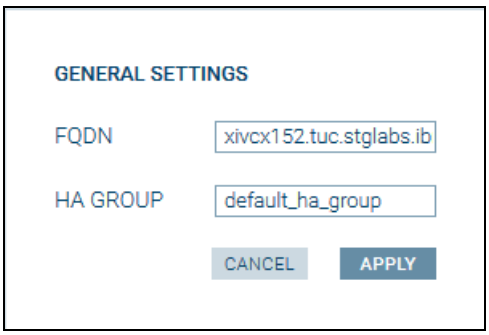

Figure 18 Filling general settings form

c. To verify whether a certificate needs to be generated for this IBM Spectrum Control server, click the **Configuration** icon, then on **SERVER CERTIFICATE**, as shown in Figure 19.

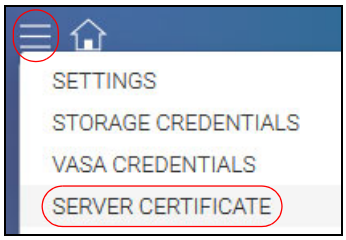

Figure 19 Launching server certificate form

d. A certificate similar to the one shown in Figure 20 on page 13 should already be existing and be valid at the date of your configuration.

   In any case, it is required to regenerate the certificate, so that the FDQN previously generated is integrated in the certificate. Complete the fields on the form and click **Generate**, as shown in Figure 20 on page 13.

   After the certificate is generated, log out of IBM Spectrum Control GUI and log in again to allow IBM Spectrum Control server to complete the certificate generation.

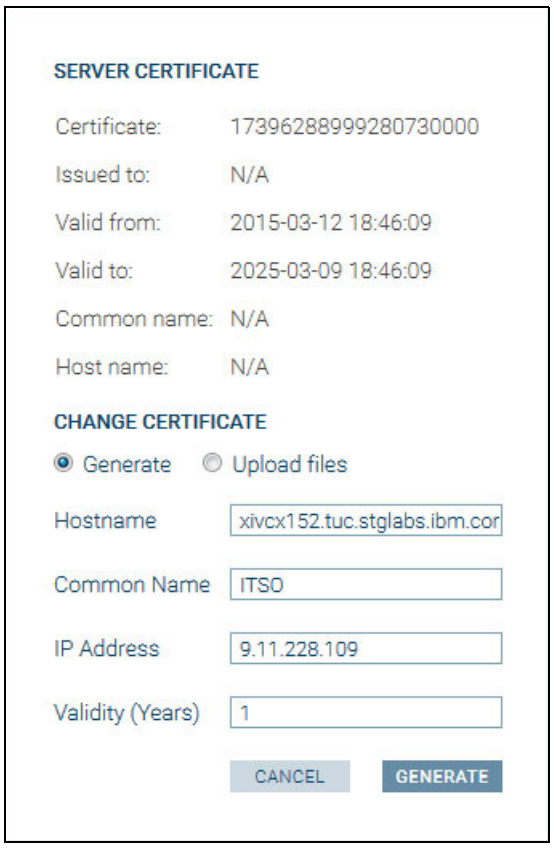

Figure 20 Generating server certificate

4. Complete the following steps to configure VASA credentials:
   a. Click the **Configuration** icon, then select **VASA CREDENTIALS** to set up the VASA credentials in IBM Spectrum Control as shown in Figure 21.

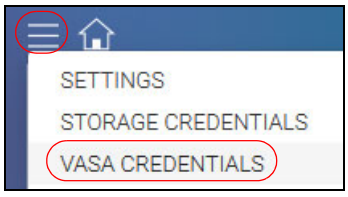

Figure 21 Calling VASA credentials form

b. The VASA credentials form opens. Create the credentials that you want, as illustrated in Figure 22. Those are the credentials to be used at vCenter

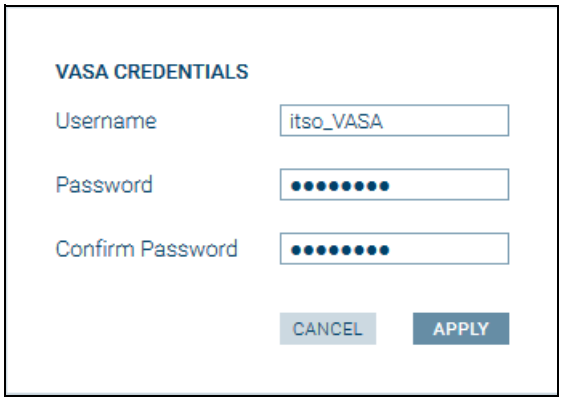

Figure 22 Creating VASA credentials

5. Perform the following steps to configure your XIV credentials in IBM Spectrum Control:

a. Click the **Configuration** icon, then select **STORAGE CREDENTIALS** as shown in Figure 23 to call the storage credentials form.

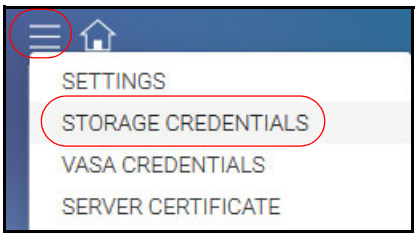

Figure 23 Calling the storage credentials form

b. Set storage credentials, which should be common to all the storage devices that will be connected to your IBM Spectrum Control server, and in particular your IBM XIV, as shown in Figure 24.

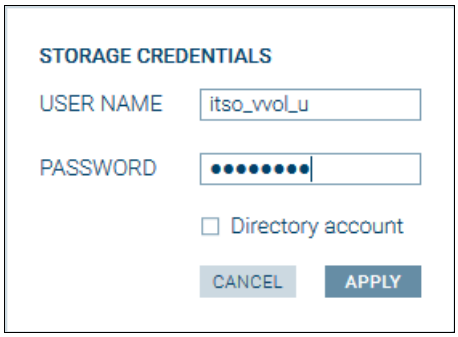

Figure 24 Providing IBM XIV credentials to IBM Spectrum Control

6. Complete the following steps to add your IBM XIV to IBM Spectrum Control:
   a. Click the **Plus** icon next to the **ARRAYS** pane to add your XIV to the IBM Spectrum Control, as shown in Figure 25.

Figure 25 Calling the Add New Array form

   b. Complete the **Add New Array** form with your XIV IP address or host name as shown in Figure 26.

Figure 26 Adding your IBM XIV

   c. After the XIV address is given, the XIV system is displayed as depicted in Figure 27.

   Note that the Free size shown in Figure 27 corresponds to the size that was defined in step b on page 6.

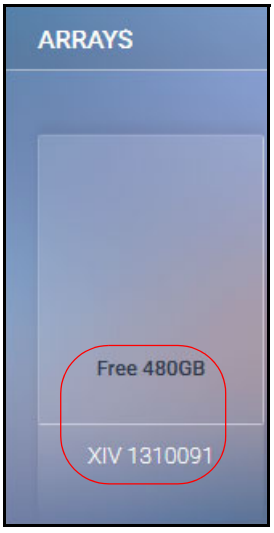

Figure 27 Displaying your IBM XIV

d. You can optionally click the icon shown in Figure 28 to display the XIV properties.

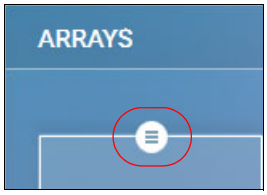

Figure 28 Opening XIV properties

The XIV properties window is displayed as shown in Figure 29. Note that no service is defined yet, which is the object of the following steps.

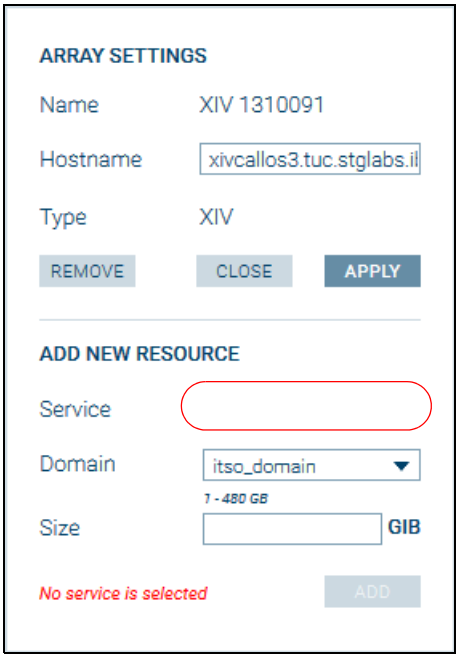

Figure 29 Showing XIV properties

7. Within IBM Spectrum Control server, a virtual storage is defined with a *storage service* and a *storage space*. Therefore, you must first define a storage space. For that purpose, complete the following steps:

   a. Click the **Configuration** icon, then click **Add new Space** to add a storage space to your IBM Spectrum Control, as shown in Figure 30.

Figure 30 Calling the Add New Space form

b. Provide a name for your new storage space and click **APPLY** as shown in Figure 31.

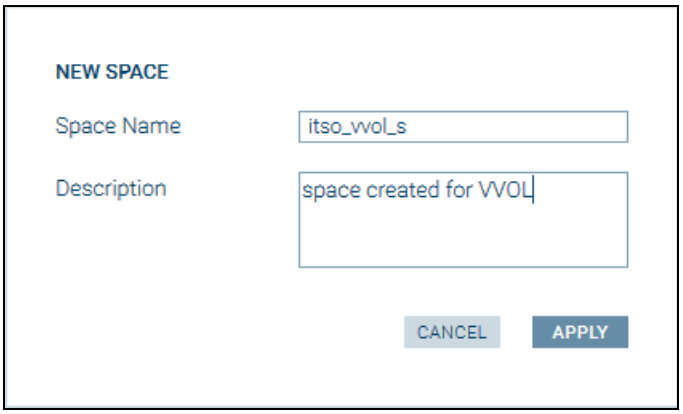

Figure 31 Adding a storage space

IBM Spectrum Control GUI automatically brings you to this newly created storage space.

8. Now that storage space is defined, a storage service must be configured. A storage service is the combination of storage resources and associated user-defined policies, such as encryption and mirroring. Complete the following steps to add a VVOL-enabled service to the newly created storage space:

   a. From your newly created storage space, click the **Plus** icon next to the service pane, as shown in Figure 32.

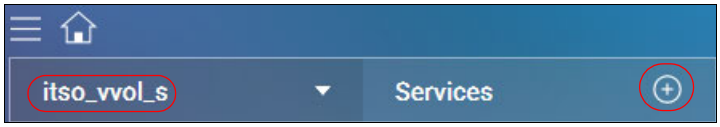

Figure 32 Calling the Add New Service form

a. The **NEW SERVICE** form is displayed. Complete it as shown in Figure 33. Specify features fulfilled by this service according to your needs. Do not forget to select **VVOL Service**.

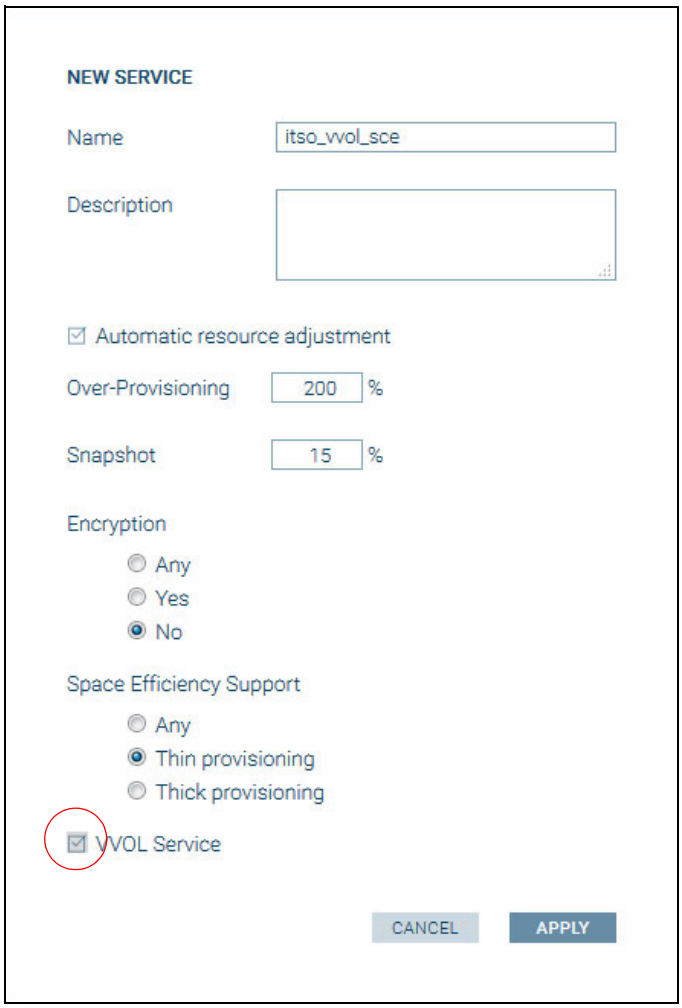

Figure 33 Adding a VVOL-enabled service

b. The service now appears in your newly created space, as shown in Figure 34.

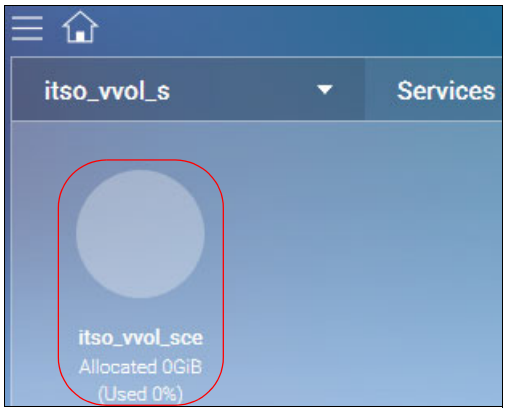

Figure 34 New VVOL service added

9. Perform the following steps to add a storage resource for this newly created VVOL-enabled service:

   a. Click the service that you want to use for the resource to be created, as shown in Figure 35 (the circle is darker after you select it).

Figure 35 Clicking the chosen service for the resource to be created

   b. Click the **Properties** link on the Array (IBM XIV Storage Array attached) as shown in Figure 36.

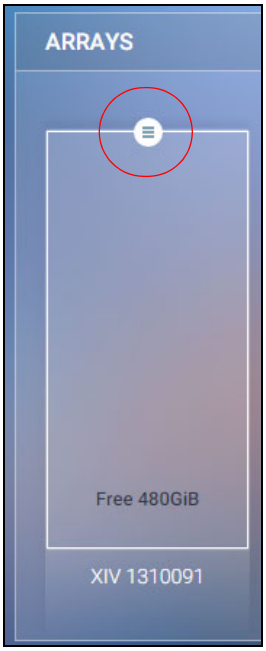

Figure 36 Clicking the Array Properties icon

   c. Enter the appropriate details to attach a new storage resource.

Note: Wait a few seconds for the VVOL service to be activated on the storage array

As shown in Figure 37, the selected service is now displayed. Enter the appropriate size for your resource, then click **Add**.

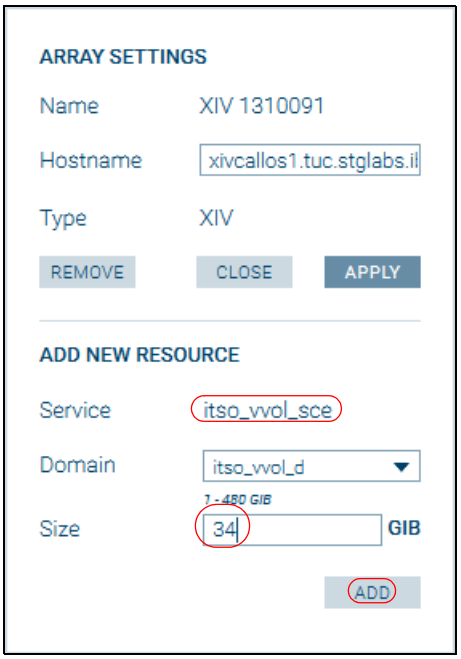

Figure 37 Adding a resource

d. The created storage resource now appears in the array, as shown in Figure 38.

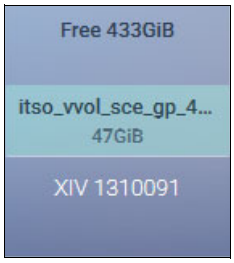

Figure 38 Created resource

The associated service also shows that it is now used, as shown in Figure 39.

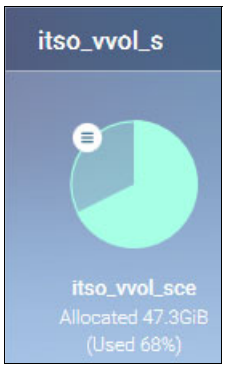

Figure 39 Service now shows used

10. In the XIV GUI, as admin user, you can now see the associated pools for this storage resource:

    a. Click the **Pools** icon, then select **Storage Pools** as shown in Figure 40.

Figure 40 Opening the Storage Pools window

    b. Three pools have been created for this storage resource, pertaining to the same pool group, as shown in Figure 41.

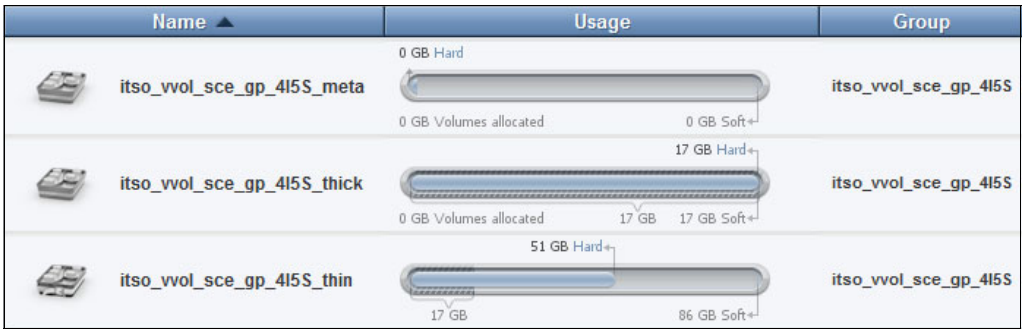

Figure 41 Pool groups that are associated to created storage resource

These three pools are within the same pool group:

Meta Pool	Holds VMware virtual machine-related management metadata
Thick Pool	For thick provisioning
Thin Pool	For thin provisioning

VMware vCenter and IBM Spectrum Control configuration

After both XIV and IBM Spectrum Control have been configured, IBM Spectrum Control can make vCenter aware of the XIV system. To do so, complete the following high-level steps:

- Register IBM Spectrum Control as VASA storage provider in your VMware vCenter.
- Register your vCenter in IBM Spectrum Control server.
- Attach your IBM Spectrum Control configured services to your vCenter.
- After all of the above steps are complete, the storage resources configured by IBM Spectrum Control in step 8 on page 17 are seen by VMware vCenter as *storage containers*. Therefore, you can now configure VVOL datastores in vCenter.
- You can then define VVOL datastores with associated VMware storage policies.

These steps are detailed below.

Register IBM Spectrum Control in vCenter

To register IBM Spectrum Control in VMware vCenter, complete these steps:

1. Go to the vCenter Web Interface, and log in as an administrative user. Click **Home** → **Hosts and Clusters**, click the vCenter server, and then select the Manage tab and the Storage Providers tab. Doing so displays the storage provider page as shown in Figure 42.

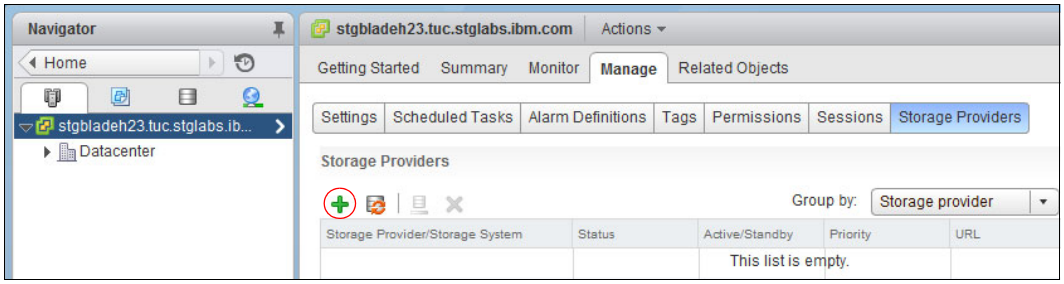

Figure 42 Displaying storage provider vCenter page

2. Click the **+** icon. The New Storage Provider window shown in Figure 43 is displayed. Complete the fields as follows (notice the use the VASA 2.0 URL):

Name	Any name describing your IBM Spectrum Control server
URL	`https://IBM_Spectrum_Control_IP_address:8443/services/vasa`
User name	The same user name as defined in Figure 43
Password	The same password as defined in Figure 43

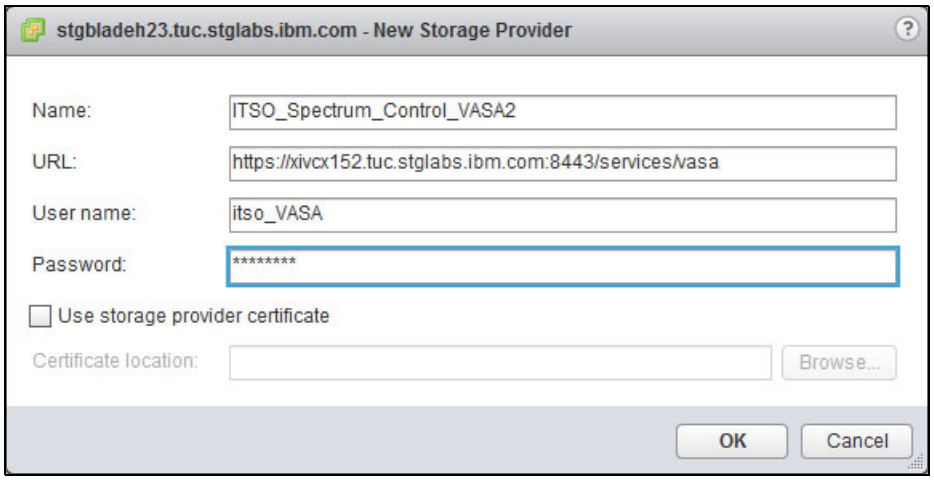

Figure 43 Filling new storage provider vCenter form

3. vCenter starts its registration process as shown in Figure 44.

Figure 44 vCenter registering storage provider

4. Then, vCenter asks you to verify the IBM Spectrum Control security certificate, as shown in Figure 45. Click **Yes** to proceed.

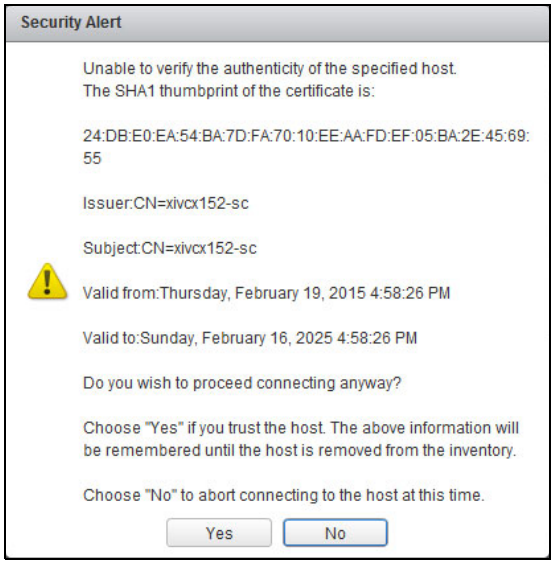

Figure 45 Requesting that the IBM Spectrum Control certificate be trusted

5. The IBM Spectrum Control storage provider now displays in vCenter as shown in Figure 46.

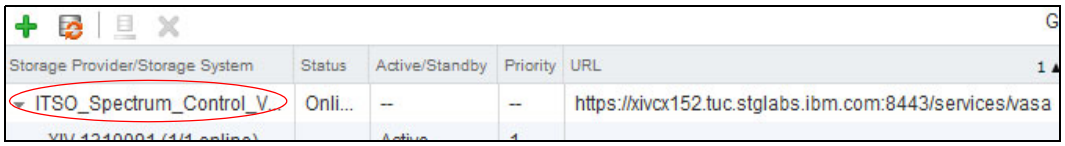

Figure 46 Registered IBM Spectrum Control server

You can verify that IBM Spectrum Control indeed accepted vCenter registry by going to the IBM Spectrum Control GUI Settings, and clicking TRUSTED CERTIFICATES, as shown in Figure 47.

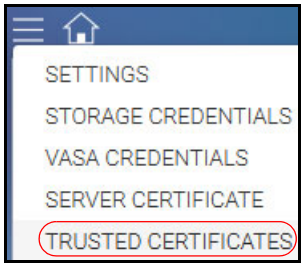

Figure 47 Calling trusted certificate window

The window should show the vCenter trusted certificate, as shown in Figure 48.

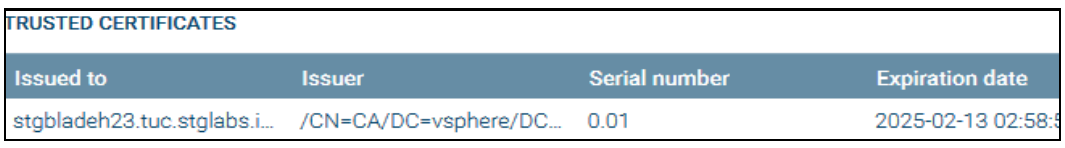

Figure 48 vCenter trusted certificate

Configure a VMware VVOL datastore

The following steps need to be completed to configure a VMware VVOL datastore:

1. From the vCenter Web Interface storage view, click **New Datastore**, as shown in Figure 49.

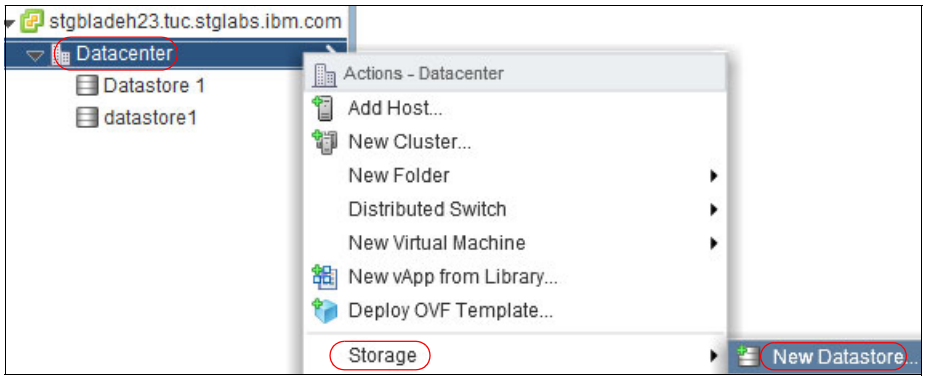

Figure 49 Starting the VMware new datastore wizard

2. On the **Location** tab, select your location and click **Next**.
3. On the Type tab, select **VVOL** and click **Next**, as shown in Figure 50.

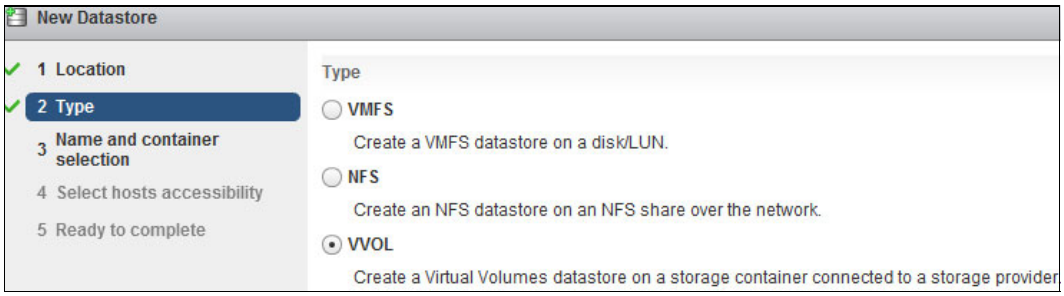

Figure 50 Selecting VVOL datastore type

4. On the Name and container selection tab, select the storage container of your choice for this VVOL datastore, as shown in Figure 51, and click **Next**. You can recognize the storage space that you defined in Spectrum Control Base in item b on page 17. This storage space can contain different services with different capabilities.

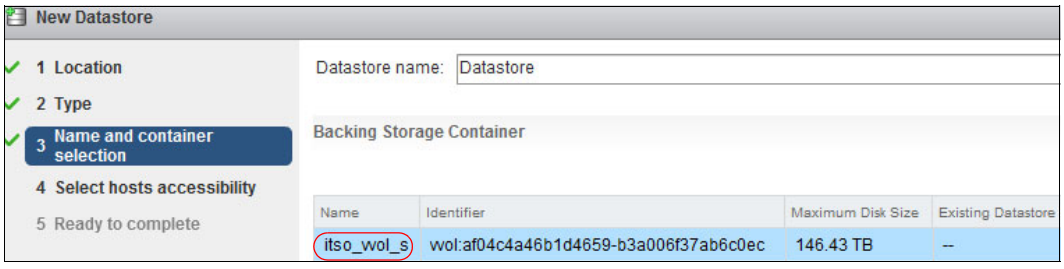

Figure 51 Selecting the storage container

5. On the Select hosts accessibility tab, select the host of your choice and click **Next**.
6. The Ready to complete tab is displayed. Click **Finish** to begin creating the datastore.

7. Click the created datastore, which should display its properties as shown in Figure 52.

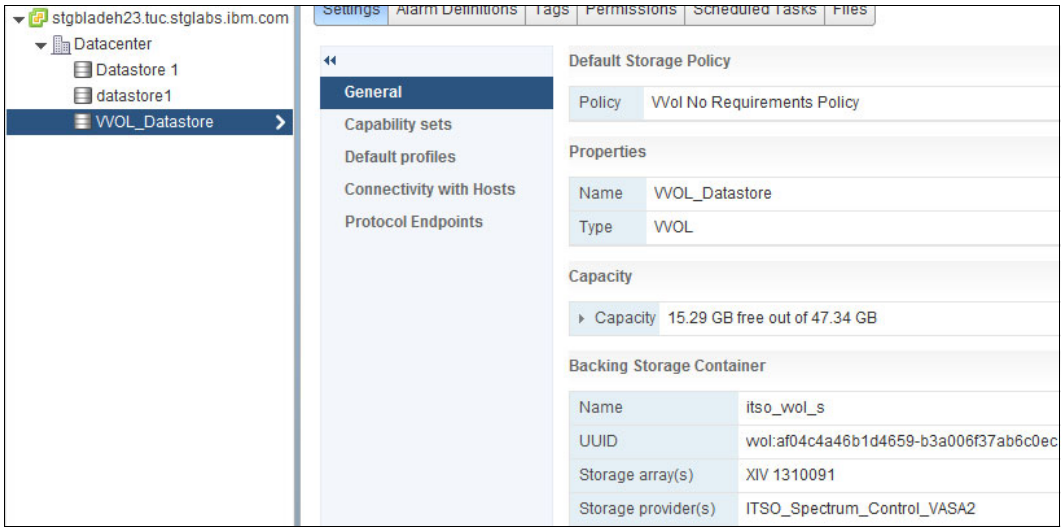

Figure 52 Created VVOL datastore settings

8. If you click **Capabilities sets**, the services and capabilities configured at the IBM Spectrum Control Base server level in item 8 on page 17 are displayed, as shown in Figure 53.

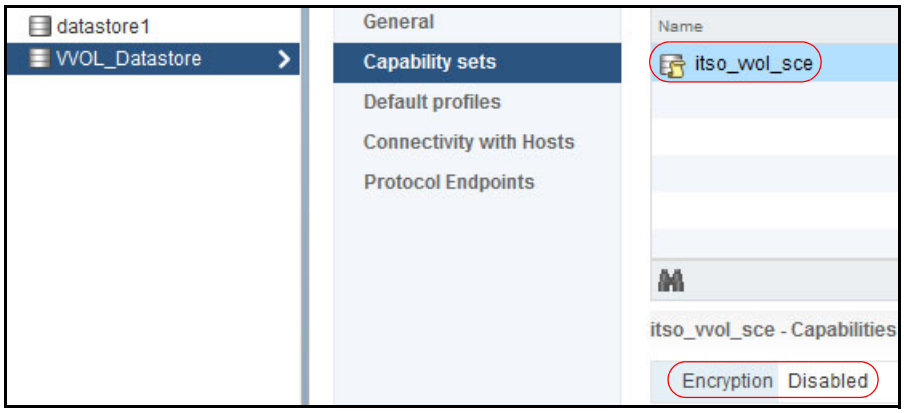

Figure 53 Showing VVOL datastore capabilities

Defining VMware storage policies

Complete the following steps to define the VMware storage policies:

1. From the vSphere Web Client Home, click **Policies and Profiles** → **VM Storage Policies**.
2. Click the icon that is circled in Figure 54 to create a virtual machine storage policy.

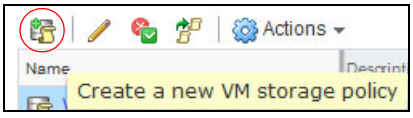

Figure 54 Create VM storage policy icon

3. Provide a name for your policy, and click **Next** twice.

4. On the 2a Rule-set 1 tab, complete the wizard as shown in Figure 55.

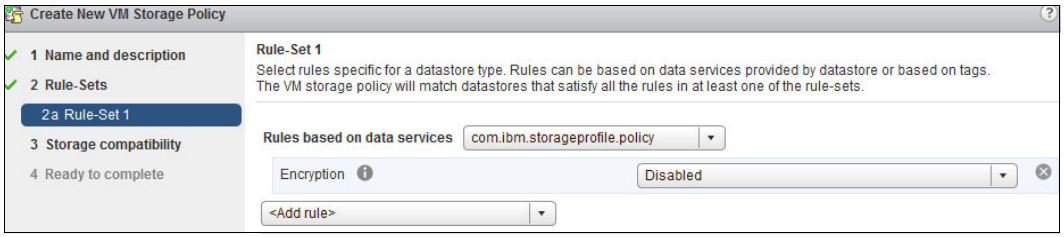

Figure 55 Defining one rule

5. Repeat the above steps for all of the rules that you need.
6. Verify on the storage compatibility that the defined rule set corresponds to the VVOL datastore you expect, as shown in Figure 56.

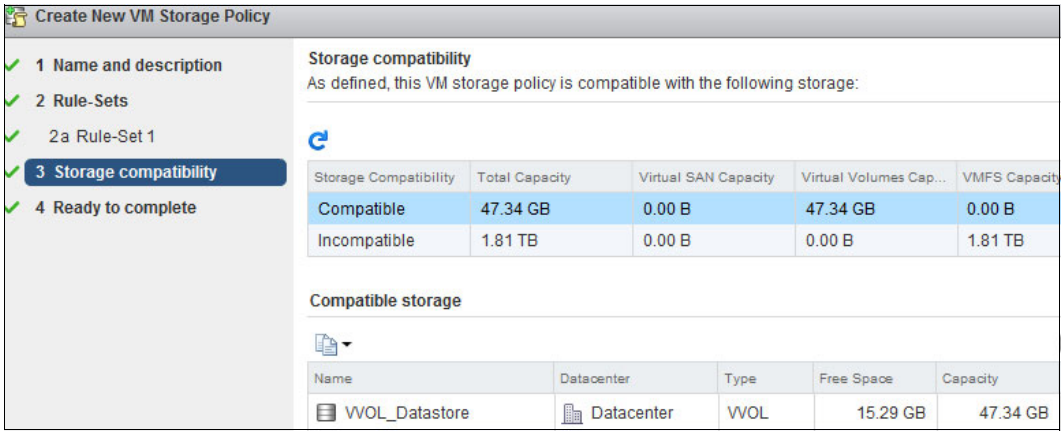

Figure 56 Verifying storage compatibility

7. Click **Next** and then **Finish**; Your policy is created, as shown in Figure 57.

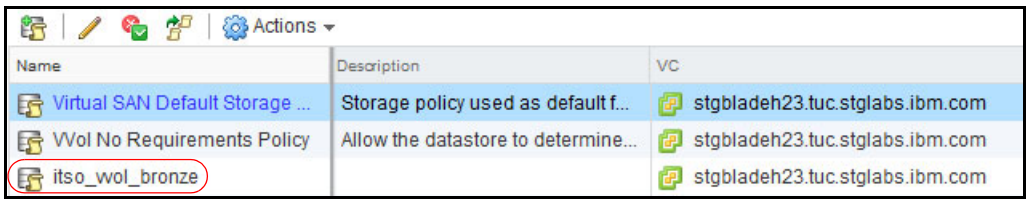

Figure 57 created VM storage policy

8. Whenever you are ready to create a VMware virtual machine, you are now able to select a VM storage policy that will take you to the VVOL datastore fulfilling that policy, as shown in Figure 58.

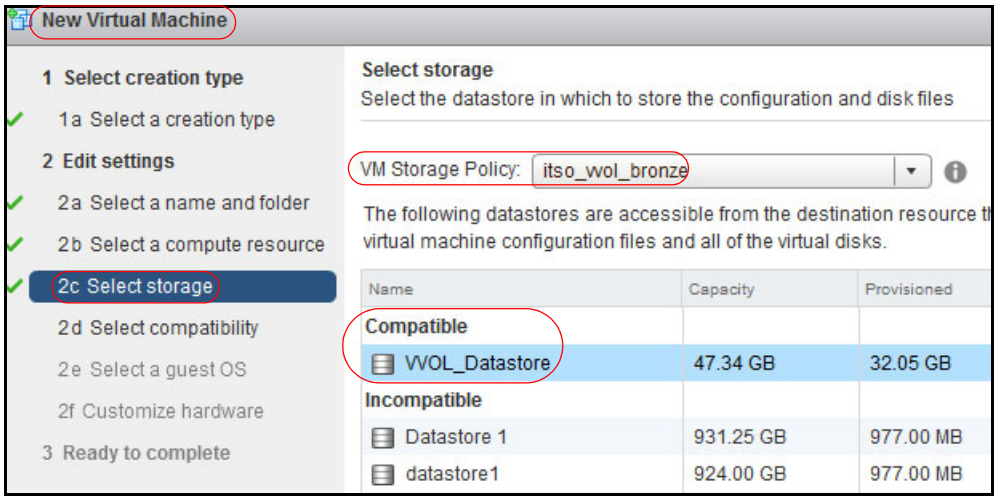

Figure 58 Selecting appropriate storage when creating a VMware virtual machine

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